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IN REVIEW:
Research in
Maryland Agriculture

SEVENTY-EIGHTH ANNUAL REPORT

BULLETIN A-145

NOVEMBER 1966



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1964-1965

**IVERSITY OF MARYLAND
ULTURAL EXPERIMENT STATION**

**BULLETIN A-145
COLLEGE PARK
MARYLAND
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1964-1965

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AGRICULTURAL EXPERIMENT STATION
COLLEGE PARK, MD.

*To The Governor of Maryland,
the Board of Regents,
and the President of the University of Maryland*

I transmit herewith the Seventy-Eighth Annual Report of the University of Maryland Agricultural Experiment Station, as established by Act of Congress, March 2, 1887, containing an account of research and experiments conducted during the fiscal year ending June 30, 1965, and a statement of the receipts and disbursements for the same period.

I. C. Haut
Director

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IN REVIEW: Research in Maryland Agriculture

AGRICULTURAL ECONOMICS

Research in the Department of Agricultural Economics is centered on the application of economic analyses to the problems and opportunities of agriculture; including appropriate areas of farm production, agri-business and consumer demand, and the interrelationships of agriculture and the total resources of the economy, domestic and international. It involves the generation of knowledge on which to base decisions concerning efficient acquisition of farm production inputs, organization of non-farm resources, off-farm marketing processes, and the integration of business, human and other resources related to agriculture so as to contribute significantly to general economic development.

Improving Auction Warehouse Facilities and Methods Of Marketing Maryland Tobacco

An important phase of this study clearly shows that recent trends in the consumption of American blend cigarettes in Switzerland is a potential threat to the Swiss market for Maryland tobacco. Maryland brands have dominated the Swiss cigarette market for many years, but since 1960 the proportion has fallen below 50 percent for the first time in more than 25 years. Meanwhile, the consumption of several

American blend brands manufactured in Switzerland, and containing little, if any, Maryland tobacco, has been increasing very rapidly.

The consumption of Maryland brands still leads, but has leveled off while American blend brands are still rising sharply in popular favor with Swiss consumers.

Project A-26-bf

The Impact of Institutional Factors on Milk Assembly, Processing and Distribution Systems and Practices

Preliminary work on this project indicates that the changing pattern of regulations, customs and legal restrictions exert a major influence on the fluid milk trade system in this area.

The institutional pattern consists of such factors as the market structure, local health ordinances, anti-trust restrictions and minimum price orders.

These factors are all partially beyond the control of the milk trade system, but at the same time subject to changes initiated by it. A more completed documentation of the causes and consequences of these changes since World War II is the ultimate objective of this study.

Project A-26-br

Acquisition and Use of Capital on Large Farms

There are several ways of measuring the financial progress of farmers. The measure most commonly used is annual labor income. Another method, not so commonly used but probably more meaningful, is the increase in the farmer's net worth over a longer period of time. The latter method was used in this project.

The farm assets, nonfarm assets and liabilities of each farmer included in the study were obtained for the year he started farming and as of December 31, 1961. These operators had been farming for themselves an average of about 21 years. Their financial progress during this time is shown in the accompanying table.

Increase in average net worth of 50 Maryland dairy and grain farmers.

Item	Year started farming	December 31 1961	Increase in Net Worth
— dollars —			
Farm assets			
Farm real estate	6,542	76,374	69,832
Livestock	2,182	16,538	14,356
Machinery (Inc. $\frac{1}{2}$ auto)	3,271	22,019	18,748
Feed and supplies	384	10,550	10,166
Total farm assets	<hr/> 12,379	<hr/> 125,481	<hr/> 113,102
Nonfarm assets			
Nonfarm real estate	237	2,178	1,941
Automobile ($\frac{1}{2}$)	376	1,045	669
House furnishings and equipment	899	3,656	2,757
Cash, stocks, bonds, checking accounts, & life ins. (cash value)	1,103	7,238	6,135
Loans due operator	220	1,225	1,005
Other	48	220	172
Total nonfarm assets	<hr/> 2,883	<hr/> 15,562	<hr/> 12,679
Total — all assets	<hr/> 15,262	<hr/> 141,043	<hr/> 125,781
Liabilities			
Mortgages on farmland and buildings	3,682	19,183	15,501
Mortgages on other real estate	0	50	50
Mortgages on farm chattels	1,818	3,648	1,830
Unsecured farm loans	430	956	526
Personal loans from individuals	638	813	175
Total liabilities	<hr/> 6,568	<hr/> 24,650	<hr/> 18,082
Net Worth	<hr/> 8,694	<hr/> 116,393	<hr/> 107,699

Project A-18-at

Analysis of the Impact of Farmer Cooperatives On the Agricultural Economy of Maryland

Farmer cooperative associations perform an important function in the marketing, purchasing and service activities of Maryland farmers. In recent years cooperative marketing in Maryland accounted for over 25 percent of the total farm income from marketing, while the farm supplies purchased cooperatively amounted to over 20 percent of total farm supplies purchased.

Milk and milk products make up the most important commodity handled cooperatively in Maryland. In recent years between 80 and 85 percent of the milk produced in Maryland was marketed cooperatively.

Livestock and poultry feeds are the most important commodities purchased cooperatively. Of the nearly \$75 million spent for feed in 1962 nearly 20 percent was purchased through farmer cooperative associations.

In terms of dollar volume marketed by cooperatives, grain and soybeans is second in importance, accounting for approximately 28 percent of farm sales. Cooperative marketing of tobacco is important to the Southern Maryland area dependent on it as a major cash crop. Maryland cooperatives market between 35 and 50 percent of the Maryland tobacco, which is between 6 and 10 percent of the total cash marketing receipts for all Maryland farmers.

Other major production items purchased through Maryland cooperatives

are petroleum fertilizers and seeds. Although seed is a relatively small dollar volume item, cooperatives supply 44 percent of the value of all seed purchased. Cooperatives provide approximately one-third of the \$16 million fertilizer purchased by Maryland farmers.

Maryland cooperative associations also provide marketing, purchasing and related services for many commodities and supplies which do not appear as large dollar items, but which are essential to the success of a modern farming operation.

Farmer purchasing cooperatives are concerned with the situations of serving the needs of both large and small volume purchasers on an equitable basis. In some cases, special volume discount programs have been established. It was found that the pricing programs may be improved by: (1) having a carefully planned written policy statement which is publicized and available to all patrons; (2) basing pricing policy on savings directly allocated to volume purchases; (3) defining and adhering to special conditions for large volume purchasers; (4) arranging for suitable credit for large volume users; (5) periodically reviewing pricing policy to determine if it is operating in the best interest of all members.

Project A-26-bg

Western Maryland Resources Study—1964-65

A study of the human, natural, and institutional resources in Western Maryland was initiated in January 1965. This three-county Appalachian area was studied to inventory and evaluate resource development problems and potentials in a region that has not shared

fully in the overall economic growth of the State of Maryland and the United States.

The Western Maryland region, consisting of Allegany, Garrett, and Washington Counties, composes the western extremity of the state. The Federal

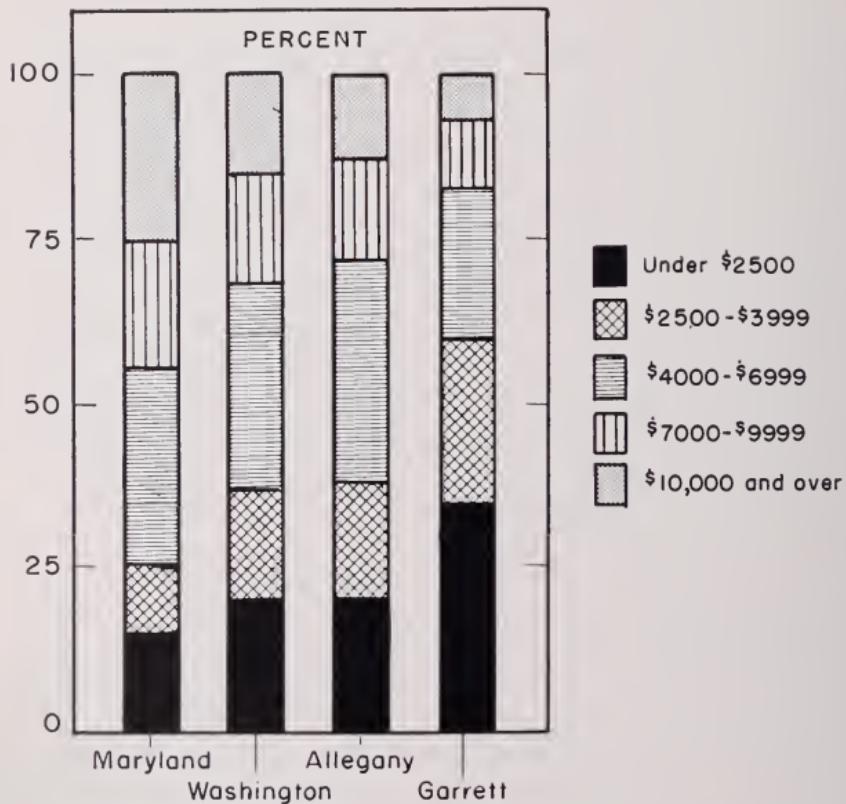
Government has designated these counties as a part of the Appalachian region.

Objectives of the study are: (1) provide an inventory of Western Maryland resources, including land, water and people; (2) delineate past growth and decline patterns which will probably recur; (3) develop a basic document for use by professionals and laymen working for the future development of the region.

The past growth patterns of this region in population and economic expansion were closely tied to the extractive industries of farming, mining, minerals,

and forestry. As this area developed its primary industry, it simultaneously created flourishing transportation, construction, and manufacturing sectors of economic activity.

The most recent phase of growth has been with the quaternary patterns of regional development. These patterns involved the increased importance of education and research and development activities which affect the future growth prospects of the local economies in Allegany, Garrett and Washington counties as well as the whole three-county region. This new phase of development places increased em-



Maryland households by income groups, state and political subdivisions, 1964.

phasis on the purely qualitative aspects of human welfare and activity in contrast to the basically quantitative aspects associated with the attainment of basic necessities of life.

Industrialization has typically been regarded as the standard route to regional development; and it has been of central importance to the development of Western Maryland. Some alternative methods of regional development in addition to industrialization in Western Maryland include: (1) the development of improved and expanded educational facilities; (2) improved highway and transportation systems; (3) better agricultural practices and resources management, and (4) development of recreational resources.

Regional development is a complex process involving a wide range of social, economic, and administrative factors. In order to provide in Western

Maryland for wider ranges of economic opportunities, improved educational and other public services and improved resources management, sustained comprehensive regional efforts will be required.

The counties and individuals of Western Maryland have demonstrated capacity to adjust to changing economic, political and social conditions in the past. A renewed effort and rededication is needed now to meet the forces of change in effect, and those likely to occur in the future. The level and quality of life of the people in this area of Maryland can be enhanced steadily in the future if they and their leaders devote major emphasis upon management of their resources, with maximum concern for their human resources with well directed activities for more rapid development.

Special Study

Dairy Adjustments and Supply Responses in Maryland and the Northeast

A linear programming analysis has been made for the Eastern Shore area of Maryland. This analysis was completed on the IBM 7094 computer. Seven bench-mark or representative farms were established for this region based on restrictions of crop land, winter labor availability, dairy housing capacity, and capital available. The bench-mark farm resources were determined from farm survey records collected during the summer of 1961. A variable milk price was used to compute the response of milk production in this area to increased price. While there was some increase in milk production

at relatively high price levels, the dairy enterprise did not show a large potential for expansion in the lower part of the Delmarva Peninsula.

Cash grain enterprises, primarily corn and soybeans, provided the most profitable use of resources on most of the farms. The major livestock enterprise in most of the computed farm plans included broilers, hogs, or yearling feeder steers. Additional work is in progress on estimating returns to better-than-average levels of production management efficiency.

Project A-18-au

Economic Aspects of Beef Cattle Production

During the last decade, prices of choice feeder steers varied between \$16 and \$34 per hundredweight. Over the same period, prices of choice slaughter

steers varied between \$18 and \$29 per hundredweight. In previous analyses the purchase of 450-pound feeder steers and the sale of 1100-pound slaughter

cattle was found to be the most profitable beef system under usual price-cost relationships and common resource situations in Maryland. The effects of feeder - price slaughter - price relationships on the most profitable level of output for assumed resource situations were analyzed in the latter phases of this study.

One resource situation consisted of a 243 acre farm with 221 acres in open land and 142 acres of plowable land. The labor force consisted of the operator and a small amount of family labor and a capital investment of \$134,000.

The relationship between the most profitable number of slaughter cattle and the price of slaughter cattle when other factors were held constant is shown in the adjoining graph. The price of feeder cattle in this case was assumed to be \$27 per hundredweight. When the price of slaughter cattle was less than \$23 per hundredweight, the optimum combination of enterprises on

this farm included no slaughter cattle since other enterprises considered were more profitable. When the price of slaughter cattle reached \$33 per hundredweight, resource restrictions permitted no further expansion in slaughter cattle numbers.

The relationship between the most profitable number of purchased feeders and the price of feeders when other factors were held constant is shown in the second graph. The price of slaughter cattle in this case was assumed to be \$27 per hundredweight. When the price of feeders was greater than \$35 per hundredweight, the optimum combination of enterprises included the purchase of no feeder cattle, since other enterprises considered were more profitable. When the price of feeders declined to \$21 per hundredweight, resource restrictions did not permit further expansions in numbers.

Project A-18-av

Organization of the World's Agricultural Resources

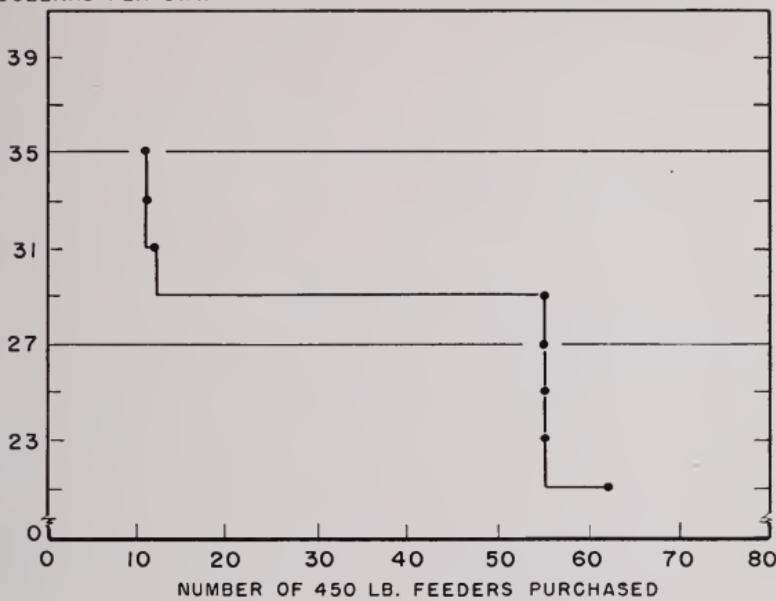
Learning more about the institutions affecting the productivity of agriculture in various cultures of the world is a crucial step in attempts to make recommendations on how to change agricultural resource organization in such a way as to increase productivity. This research project is now starting a systematic survey of the way agricultural resources are organized in various parts of the world. Field work so far has been sponsored by the Agricultural Development Council and has involved three different kinds of agriculture in Africa. Further field work is planned in India and other parts of the world as funds become available.

The first report in the series on agricultural resource organization was released this past year entitled *The Struc-*



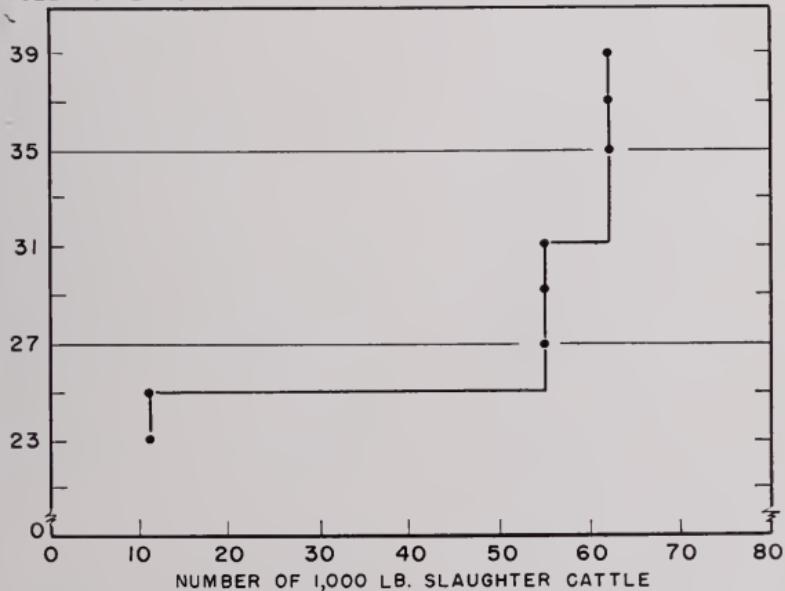
An Indian peasant farmer carries his plow to his field on his shoulder. This custom is perpetuated, in part, by the land tenure system of his village which has not provided for farm lanes over which wheeled machinery can be drawn.

DOLLARS PER CWT.



Relationship between optimum number of feeder cattle purchased and price of feeder cattle for a beef cattle farm.

DOLLARS PER CWT.



Relationship between optimum number of slaughter cattle and price of slaughter cattle for a beef cattle farm.

ture of Algerian Socialized Agriculture. This report appeared as Experiment Station Miscellaneous Publication Number 527. Field work on shifting agriculture in Zambia is completed and the write-up of the results is in process. Rudimentary shifting agriculture in Uganda is currently being studied and analysis of the results of this field work will begin next year.

The project leader presented a keynote paper at the seminar on "Institutional Structures and Cultural Values as Related to Agricultural Development" at Washington State University. This seminar was sponsored by the Agricultural Development Council.

Project A-18-ax

Profitability of Relative Feed Handling Systems On Maryland Dairy Farms

Differences in feed handling systems are often associated with the method of milking and housing dairy cows. In terms of milking efficiency, the herringbone milking parlors had the largest number of cows milked per man hour and the lowest daily milking time per cow in man minutes. The side opening in-line milking parlors were intermediate in labor requirements. The stanchion barn systems required the most labor for the milking operation. However, the differences in labor used among the three milking systems were not statistically significant at the .05 level because of the small number of observations and the wide variations within each system. However, the variations within each of the three types of milking systems were significant at the .05 level. This indicated that the ability, skill, and efforts of men in performing the milking chore were more important factors in determining overall milking efficiency than the type of milking facility in which they worked.

The number of milking machines per operator was a very important factor in determining worker performance of milking operations. As the number of milking machines per operator increased from two to four, there was a statistically significant increase in the number of cows milked per man hour.

If fewer than two machines were used per operator, unused and non-productive time generally resulted and milking efficiency was sacrificed. This study, as well as studies in other states, has shown that certain efficiencies can be gained in parlor milking systems by increasing the number of milking machines per operator up to four units. Few efficiencies are gained by attempting to increase the milking machines per man ratio to five or six. Generally, in the stanchion barns with direct pipeline or dump or transfer stations, three units per operator are most efficient. If the milk is hand-carried, an average of 2 to 2½ milking machines per operator is most efficient.

As the number of men who milked at the same time increased, there was a decline in the average number of milking machines per operator. This resulted in a decline in the number of cows milked per man hour. As herd size increased, there was a slight decline in the number of cows milked per man hour. However, the decrease in efficiency associated with the larger herd appeared to be the result in the decline in the number of milking machines per operator.

The time required to remove and feed a ton of hay that was stored on the ground was less than the removal and

feeding time from mow barns, but this time difference was not statistically significant. Silage was removed from upright silos mechanically with top unloaders and manually with forks. All silage in horizontal silos was removed with tractor scoops except on two farms where some of the silage was self-fed by the dairy herd. Manual silage feeding methods predominated. The most efficient silage removal and feeding system was one in which all silage was removed and fed mechanically via a mechanical unloader and auger, from two very large silos. The removal and feeding time for this system averaged only 8.8 man minutes per ton of silage fed.

A relatively small improvement in milking efficiency can probably save a

farmer more labor than a rather substantial improvement in feeding efficiency. This results because the yearly man labor requirements per cow for milking are considerably greater than those for feeding roughages. Therefore, greater total labor savings can generally be achieved on most Maryland dairy farms by concentrating dairy farmstead adjustments on the milking phase of the dairy operation. However, improvements in feeding methods are frequently associated with changes in milking arrangements and should definitely be undertaken whenever they seem to be profitable.

Project A-18-ay

The Transfer of Farm and Open Country Real Estate In Six Maryland Counties, 1962

In this study an attempt was made to discover some of the characteristics of the open country land market within the State of Maryland and more specifically within Frederick, Harford, Prince Georges, Queen Annes, St. Marys and Somerset Counties.

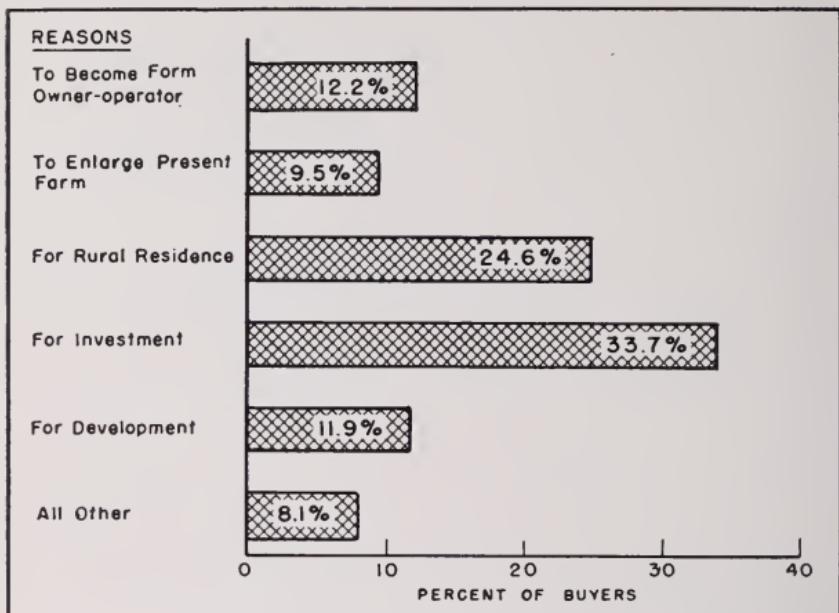
The demand for open country real estate in Maryland seemed to stem from two main sources. One source was the purchase of tracts for subdivisions into residential and development properties. The second was the assimilation of smaller tracts into larger farming units.

The following factors seemed to be price deterrents in the Maryland open country real estate market in 1962:

- (1) The rate of population growth in these counties was closely related to the price per acre of land.

- (2) The population density of the six counties was positively related to the price per acre of land. This relationship was not as strong as the relationship between the population growth rate and land prices.
- (3) There was a positive relationship between the mean income in the counties and the price of land per acre.
- (4) The type of road on which the property was located affected the price of land, with tracts on better roads selling for higher prices per acre.
- (5) The presence of water front on a property was apparently conducive to high land prices, since water front property was selling for higher prices per acre in four counties than property without water front.

REASONS GIVEN BY BUYERS FOR PURCHASING LAND IN SIX MARYLAND COUNTIES, 1962



- (6) The size of tract and the price per acre of land were inversely related, with smaller properties selling for higher prices.
- (7) An inverse relationship also existed between the distance to shopping areas and the price of land per acre, since properties closer to shopping areas were selling for higher prices.

Financing was generally secured from commercial banks and from the seller

of the property with only a few other sources being used. Of the buyers who borrowed, 43.6 percent borrowed from commercial banks, 35.6 percent from the seller, 4.9 percent from relatives and 6.6 percent from other individuals. The remaining 9.3 percent borrowed from life insurance companies, the Farmers' Home Administration, the Federal Land Bank, Production Credit Associations and others.

Project A-18-az

Nonfarm Use Pressures Complicate Farm Land Tax Assessments

Large areas of Maryland are feeling the impact of nonfarm use pressures on farm land. These pressure areas have been expanding rapidly in recent years, and now materially affect the prices of farm land in most of the more urban counties and parts of adjacent counties.

In addition, in several counties, especially on the Eastern Shore, demands for water-front acreages exert an influence on prices of inland farms.

These nonfarm use pressures have made it almost impossible to purchase farms within agricultural use values in

recent years in Montgomery County, where a large portion of recent farm sales have ranged from \$1000 to \$2000, and higher, per acre.

Otherwise, farm sales records in several more rural counties, during the three years, 1962-1964, show that farms were sold at prices somewhat above the usual price level for farm use. The principal secondary factors in such land price rises seem to be: (1) competition among local farm owners to add to their existing acreages to improve farm efficiency, and (2) purchasing of farms by farmers from other counties and states, after having sold their farms at high prices, and who are able and willing to pay the asking price to continue farming.

Based on similar soil productivity classes and crops grown, there is too wide a range in tax assessment value rates per acre among counties and even within counties. The use of constant, or slightly variable, assessment rates per

acre cannot be justified when crop yields vary so widely, due largely to soil differences.

The usefulness of soil data in assessing land is receiving more attention, but the assistance of expert soil scientists is desirable if such data are to be effectively utilized.

Two practical problems arise in the use of soil data. One concerns the degree of soil sub-classification which will be a practical assessment guide without being too complicated. The other is the matter of making the soil sub-classes uniform with respect to crop yields and income capitalization among counties.

A combination soil-tax map, or a soil map of the latest soil survey with a tax map overlay, seems possible in the near future in several Maryland counties. Meanwhile, assessors would profit from the use of the older soil data and maps as an aid, especially so if under the guidance of a soil scientist.

Project A-19-z

Returns to Inputs on Cash Grain and Tobacco Farms

Thirty tobacco farms have been visited and data collected on inputs used and outputs produced. Output was measured in terms of dollar gross income. Input use was classified into land in acres, labor in months, machinery and equipment investment in dollars, forage and livestock investment in dollars, and current operating expense in dollars.

The survey information has been fitted to mathematical equations by processing it through the computer center. The programmed output is being analyzed. The analysis will indicate the marginal productivity of land, labor,

and capital as well as estimates of gross farm income for tobacco farms with given land, labor, and capital supplies. The analysis will be useful in that it will provide a better basis for making farm management decisions and recommendations relative to the use or employment of various factors of production found on or made available to tobacco farms in southern Maryland.

In addition to the above analysis, a publication has been prepared on allotment distribution and major inputs used in producing Maryland tobacco.

Project A-18-aw

Growth Rates of Maryland Counties

Most of the work accomplished to date in this study consisted of examining the shift analysis developed by the U.S. Department of Commerce and its

potential for explaining economic growth in Maryland counties. The shift analysis partitions observed growth into two sectors: (1) the "competitive shift"

(i.e., how the industries in one area have grown relative to the same industries in other areas of the nation) and (2) the "industry mix shift" (i.e., the change in employment in any area that results from having a large proportion of rapidly growing industries in the economic organization of an area).

Maryland as a whole has had a "positive effect" (i.e., grew at a faster rate than the national average) in both competitive effects and industry mix effects. This is true for the periods 1940 to 1950 and 1950 to 1960. However, this study will utilize county data to more definitely pinpoint Maryland's growth areas and to test meaningful hypotheses regarding causal factors affecting county growth rates.

Work is being undertaken regarding the usefulness of the two-directional shift analysis in order to determine whether or not a third or possibly fourth effect ought to be included in the shift analysis. Once the basic shift analysis is decided upon, a computer program to analyze the data for the 3000 counties in the United States with prime emphasis on Maryland counties will be developed. The data thus generated will be analyzed during 1966 and 1967.

It is believed that the results of this study will enable county planners to develop more effective programs for economic growth and development in Maryland counties.

Project A-19-aa

U.S. Private Investment in Food Processing Plants in Latin America

This project, initiated in F.Y. 1963-64, deals with the barriers to U.S. private foreign investment in food processing plants in Latin America. General investment data on the extent of U. S. private foreign investment in Latin America were collected from several sources.

The general data sources included the U.S. Dept. of Commerce, U.S. Dept. of Agriculture, Inter-American Development Bank, Pan American Union, Embassies of Latin American countries located in Washington and Latin American trade associations located in New York City.

Data on specific investments by United States firms were obtained through questionnaires mailed to the firms known to have invested in Latin America. The questionnaires asked for information on the history, type of product, location and volume of the companies' plants in Latin America.

At the end of fiscal 1963-64 the project leader and his assistant commenced

a nine-week survey of American investors in Latin America. This study covered eleven countries and resulted in the collection of data through interviews with U.S. Embassy and AID personnel, the U.S. private firms investing abroad, American banks, as well as government and bank officials of the Latin American countries themselves.

The research found three types of barriers to U.S. investment in food processing plants in Latin America: limited markets, in some cases higher costs than those incurred by local competitors, and inadequacies of the host governments in the form of inflation, devaluation, civil disturbances, and disruptive left wing agitation. In most cases the local governments are trying, though not always successfully, to overcome these latter obstacles.

The U.S. Government has encouraged investment in Latin America through loans, investment surveys, and guarantees. It is suggested consideration be given to allowing losses due to deval-

uation as deductible for U.S. tax purposes. Could the devaluation risk be minimized in this way, investment in Latin America would be stimulated which in turn would stimulate economic

growth and contribute to political stability and increased U.S. exports in this area.

Project A-19-ab

Trends Pointing to Future Consumption and Market Potential For Meats in the Northeast

Consumption data were collected for selected cuts of beef, pork, lamb, veal and sausage from a randomly selected sample of respondents in Washington and Baltimore. The weekly average per capita consumption of the selected cuts of above named red meats were determined for the socio-economic factors of (1) occupation of the wage earner, (2) size of the family, (3) race, (4) religious preference, and (5) income of the family.

For respondents earning less than \$4,000 annually, Baltimore residents consumed slightly less beef and sausage but more pork, lamb, and veal per

week than their counterparts in the Washington area. When earning between \$4,000 and under \$11,000, the Baltimore respondents still consumed less beef and more pork, and sausage but less lamb and veal than the Washington respondents. In the high income group, the Baltimore respondents consumed on the average more beef per capita per week than the Washington respondents but less of the remaining red meats.

In total, as income increased the total pounds of red meat consumed per capita per week increased.

Project A-26-bh

Changes in the Structure of the Northeast Processed Vegetable Industry

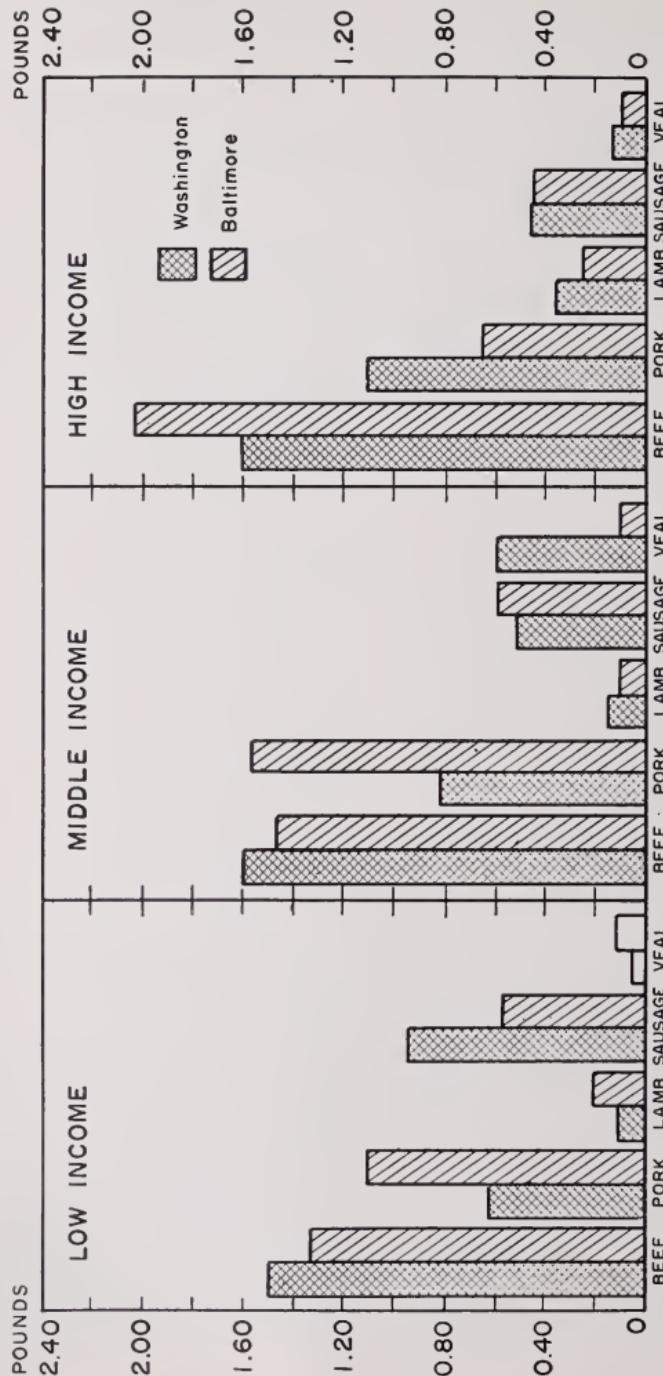
This study was initiated in an effort to discover the underlying causes of the trends toward concentration and centralization that have been exhibited in the vegetable processing industry in Maryland.

Of the two general approaches, the first approach was to analyze a sample of vegetable processing firms that had recently gone out of business in order to determine general factors that could be associated with their demise. This was done and such a listing was established. In comparing firms which had terminated operations with those that were still active in 1962, analysis showed that many of the factors common in the terminated firms were also present in the active firms.

The second approach was to make a broad study of the changes in the structure of the Maryland-Delaware vegetable processing industry. Results showed a marked tendency toward concentration and centralization but a definite lack of stated plans to cope with future structural adjustments.

Factors associated with the withdrawal of firms from the Maryland fruit and vegetable processing industry, 1950 - 1961.

1. A majority of the firms had relatively low annual outputs.
2. A majority of the firms had relatively low fixed capital investments.
3. Many firms had an excessive carry-over during the last year of operation.
(Con't. on Pg. 15)



Average per capita consumption of beef, pork, lamb, sausage, and veal for Washington and Baltimore residents earning between \$4,000 and \$11,000 annually.

Average per capita consumption of beef, pork, lamb, sausage, and veal for Washington and Baltimore residents earning above \$11,000 annually.

Average weekly per capita consumption of beef, pork, lamb, sausage, and veal for Washington and Baltimore residents earning less than \$4,000 annually.

4. Almost all of the firms processed only one product.
5. A majority of the raw product was procured on the open market.
6. A number of smaller firms showed a reluctance to respond quickly to changes in container sizes.
7. A single type of selling agent marketed the majority of the firms' pack in a limited area.
8. A majority of these firms' pack was sold under the buyer's label.

Project A-26-bj

Impact of the Chesapeake Bay Bridge Tunnel on the Marketing Of Soybeans, Corn, and Feed Derivatives of These Through the Port of Baltimore

At the completion of this research project it was concluded that the Bridge-Tunnel has had no measurable impact on corn or soybean exports from the Port of Baltimore. The general trend of corn and soybean exports from Baltimore and neighboring ports indicates by itself that the Bridge-Tunnel has not had any significant impact on these exports. In addition, the three surveys of truck transportation of corn north across the mouth of the bay cor-

roborate the above conclusion.

During the process of gathering data for the above research project, a considerable amount of data on production and consumption of farm products in Maryland was assembled. This material, together with some additional material, was organized into a bulletin entitled *A Graphic Survey of Maryland's Agriculture*.

Project A-26-bk

The Export Market for Maryland Agricultural Products

This past year the major accomplishments were the expansion of the annotated bibliography of literature dealing with agricultural trade of the European Common Market, development of freight rate data for agricultural exports to the European Economic Community (EEC) from the U.S. and within the EEC (for the North Central Marketing Regional Project 33 econometric trade model), and the completion of a study on changing patterns of world trade in butter over the past 100 years including factors causing these changes.

The annotated bibliography provides a ready description of previous studies that have been conducted in this area and will be useful to all doing research on agricultural trade with the EEC.

The freight rate data has been used in testing the NCM—33 econometric trade model. Rates to the EEC from the U.S. were found to vary considerably by commodity.

The butter trade study provides insights into the factors affecting the level of U.S. and European butter exports and imports. The most important

factors affecting butter trade are new technology, changes in population, and wars.

The findings of these studies will improve our understanding of the factors affecting trade with the EEC and thus help provide insight into how we might improve our competitive position in trade with the EEC. An increase in agricultural exports to the EEC, of course, will help to raise U.S. domestic agricultural prices and the welfare of agricultural producers.

Project A-26-bm

Preliminary Estimates of Transportation Cost Between U.S. and E.E.C. for Various Agricultural Commodities in \$/short tons.

Fresh apples	50
Canned products	40
Grains	5
Dry Milk	40
Poultry products	45-60
Meat	90
Tobacco	45-50
Vegetable oil	15
Butter	60
Cotton	35-40

Analysis of Processing Efficiency and Costs in Broiler Processing Plants

Processing is a vital part of the economically important broiler industry in Maryland. The complexities of broiler processing along with high investment costs tend to cause variations in operations and costs among plants and areas.

A project is underway to make a detailed economic analysis of Maryland's broiler processing plants. Objectives include: (1) to analyze the causes for differences in processing efficiency and costs among and within poultry processing plants in Maryland, (2) to determine plant costs, as well as labor input and output coefficients, and (3)

to assess the competitive position of plants operating in the Delmarva Peninsula.

Preliminary findings and observations indicate that there are considerable differences among plant layouts and types of operations and moderate variations among levels of technology. The main determinant of per unit plant costs seems to be plant volume. More concrete findings are not available at this time but will be forthcoming within the next year.

Project A-26-bo

Structure of Livestock and Meat Marketing in Maryland and Surrounding Areas

The number of calves, heifers, cows, bulls, steers, feeder pigs, heavy hogs, sheep, goats, and other types of stock were obtained for 14 auction markets in Maryland for each week for a 24 month period. The same data were obtained for the terminal market in

Maryland. The seasonality of the marketings of these kinds of livestock have been calculated for each auction market and for the total of all auction markets. Services offered sellers and buyers, sales policies, size of sales yards, livestock solicitation policies, dollar ex-

COMMERCIAL BROILER EVISCERATING PLANTS IN MARYLAND AND DELAWARE



penditure for advertisement, and the approximate radii serviced by each livestock market were obtained.

The livestock markets use the computed seasonal patterns of receipts to

determine what changes in management decisions need to be made to minimize fluctuations in livestock receipts.

Project A-26-bp

Economic Analysis of Alternative Marketing

Systems for Eggs in Maryland

This study was initiated July 1, 1964 and is concerned with evaluating the economic feasibility of alternative egg marketing systems in Maryland and the extent to which they (a) meet the requirements of various markets, and (b) affect the competitive position of egg marketing firms, individually and collectively. It is designed to determine and study the organizational characteristics of the egg marketing system which determine the relations of sellers in the market to each other, of buyers in the market to each other, of the sellers to the buyers, and of sellers established in the market to other actual or potential suppliers of eggs, including potential new firms which might enter the market.

In order to accomplish the above objectives, the patterns of behavior will be determined that egg marketing firms follow in adapting or adjusting to the markets in which they sell. Significant dimensions of this behavior include: 1) methods employed by the firm or group of firms in determining price and output; 2) product policy; 3) sales promotion policy; and 4) procurement policy.



At the present time data relative to the behavior patterns of 25 egg marketing firms has been collected and is in the process of analysis. The results and findings of the study will be published in 1966.

Project A-26-bq

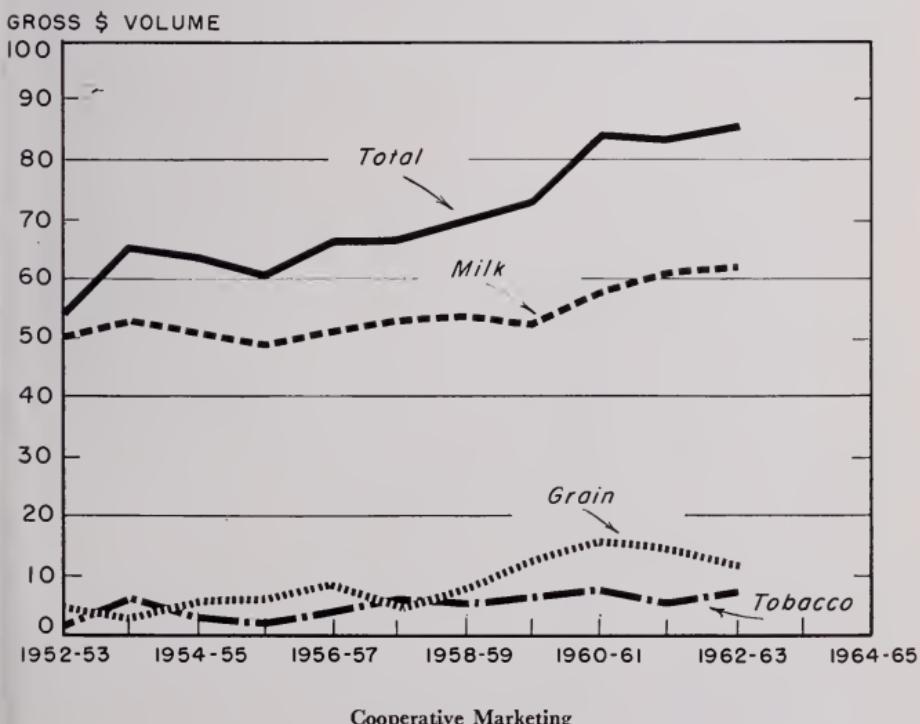
The Role of Farmer Cooperatives as Marketing Organizations

Data have been compiled on Maryland cooperative marketing activities for a ten year period, 1952-53 to 1962-63 with an analysis of the activities of the major cooperative commodities. It was found that the total gross value of all cooperative marketings has increased over 21 percent while the gross value of all farm commodities marketed in Maryland has increased only slightly over 11 percent for the same 10 year period. Milk and milk products accounting for approximately 78 percent of the gross value of all cooperative marketings and 20 percent of all farm products sold in Maryland has held approximately the same relative position

during the past ten years. Grain marketing by Maryland cooperatives has indicated a steady gain during the past ten years, increasing from a gross of over \$4 million to over \$11 million from 1952-53 to 1962-63. Tobacco marketing through cooperatives varied during the ten year period and indicated no general pattern or growth pattern.

Analysis of data obtained from Maryland marketing cooperatives will be used to determine the major advantages and disadvantages to growth of marketing cooperatives in Maryland.

Project A-26-bs



AGRICULTURAL ENGINEERING

Applications of engineering in agriculture promote efficient production, harvesting, transportation, processing and marketing of plant and animal products and the conservation of natural resources. These functions are accomplished through the application of energy to transform the crops or products or to control the environment in which these are grown, stored, processed, or marketed.

In cooperation with scientists of other disciplines, engineers seek to determine the essential environment for biological processes and the changes in products necessary to enable their use. The engineering task is then to seek the most efficient design for application of the energy necessary for management of biological systems.

It is not possible to undertake all engineering aspects of biological systems in a single department. Each department can contribute to the whole of agricultural engineering research through cooperation. This summary report includes three projects (RM-1, R-16 and R-20) which specifically contribute to regional research and also two studies of regional and national importance made in cooperation with the Agricultural Engineering Research Division, Agricultural Research Service, U.S. Department of Agriculture.

Tobacco Housing

The tobacco cured during the 1964 season in the Compact Curing facility was sold on the auction market for an average of \$72.24 per 100 pounds. The average season's auction price was \$71.28 per 100 pounds for the same grades as those sold from the Compact Curing. The net average auction sales for the entire 1964 crop was \$61.84 per 100 pounds. The compact cured tobacco was of a much higher quality than the tobacco sold for the season, which is indicated by the difference in prices.

During the 1965 season two cures were made in which two methods of filling the facility were employed. The first cure consisted of spearing 19 plants to a four-foot stick and hanging the sticks eight inches apart. Air heated to approximately 85°F was forced through

the tobacco for 72 hours after filling. The relative humidity of the air was held at approximately 85 percent during this period by keeping the facility closed and recirculating the air within the system.

After 72 hours the air was forced through the tobacco only during the day at a temperature of approximately 80°F. The cured leaves were dried once every 24 hours by natural air or heated air. Preliminary evaluation indicates that this was one of the best cures ever obtained by this method of curing.

For the second test the facility was rebuilt so that the tobacco was placed on a false floor, butts down. This floor was divided into sections that held approximately 150 plants each. The sides of each section were hinged so that the

sides could be pulled in at the top to prevent the tobacco from falling to the side. Closing the sides kept the plants upright and permitted the air to move through the tobacco more uniformly. Due to the manner in which the sections were constructed and loaded, only moderate success was obtained. Individual boxes using this same principle were

tried and were more successful. However, due to the weights involved, the boxes could not be conveniently moved by hand and should be handled mechanically. Modification and improvements in handling techniques is planned for this phase of the system.

Project RB-11-g

Environmental Requirements of Poultry

The studies conducted during this period were designed to determine the effect of moisture (i.e., relative humidity) on broiler chickens from one day to eight weeks of age.

For the first trial, half of the birds were started at 90°F and the others at 85°F. Each of these groups were divided into two moisture levels—a high level of 90 percent relative humidity and a low level below 40 percent relative humidity.

For the second trial, all pens were started at 90°F. Four levels of relative humidity (90, 70, 50 and 40) were

studied. All pens in each trial were reduced in temperature at a rate of 5° per week until 65°F was reached. The pens were then held constant at this level for the remainder of the test. The wet bulb temperature was adjusted to give a constant percent relative humidity condition for the entire test.

Birds used were White Rock Cockersels, which were not vaccinated against any disease and said to be free from PPLO. The feed used was pelletized commercial broiler ration containing a coccidiostat. A summary of the results of each trial is given in Table I.

Summary of Data

Trial I

Pen Number	1	2	3	4
Starting Temperature	85°	85°	90°	90°
Constant Relative Humidity	40%	90%	90%	35%
Number Birds in Test	101	102	100	100
Average Initial Weight, pounds	.08	.08	.08	.08
Average 8 Week Weight, pounds	4.55	4.80	4.91	4.84
Pounds feed/pounds gain	1.93	1.84	1.83	1.86
Percent/Mortality	4.9%	4.9%	5.0%	8.0%

Trial II

Pen Number	1	2	3	4
Starting Temperature	90°	90°	90°	90°
Constant Relative Humidity	90%	70%	50%	40%
Number Birds in Test	100	100	100	100
Average Initial Weight, pounds	.08	.08	.08	.08
Average 8 Week Weight, pounds	4.43	4.49	4.49	4.39
Pounds feed/pounds gain	2.02	2.07	2.07	2.13
Percent/Mortality	1.0%	2.0%	4.0%	4.1%

In Trial I, the pen started at 90°F and 90 percent relative humidity produced the heaviest birds—4.91 pounds with a feed conversion of 1.83. The 90°F and 35 percent relative humidity averaged 4.84 pounds with a feed conversion of 1.86. The pens started at 85°F and 90 percent relative humidity were only slightly lower, 4.80 pounds with a 1.84 conversion. The 85°F low humidity pen had a considerable drop in weight gain during the fourth week. There was no mortality or sign of disease. The final weight for this group was 4.55 pounds with a feed conversion of 1.93.

In Trial II, the heaviest birds were produced in the pens held constant at 70 percent and 50 percent relative humidity. The final average weight was 4.49 pounds with a feed conversion of 2.07. The lowest weight pen was at the lowest relative humidity, 4.39 pounds with a feed conversion of 2.13. The high humidity pen birds averaged 4.43 pounds with the best feed conversion of the test, 2.02.

There were no adverse effects noted on the birds from the conditions of relative humidity and temperature levels held during the study.

Project RM-1

Pneumatic Handling of Chopped Forage

The pneumatic conveying system was modified to use a 12-inch diameter pipe for transporting semidry chopped hay. Performance data were obtained using combinations of conveying air velocities, material feed rates and moisture contents of the hay. The data were used to develop relationships between the pressure drop in 50 feet of pipe, the rate of conveyance of material and the air velocity required for conveying. These relationships together with those determined for 9 $\frac{1}{4}$ - and 12-inch pipes provide basic data needed for the design of pneumatic handling systems for conveying semidry chopped hay.

The laboratory system that was constructed in 1965 was modified to use an enclosed auger as the feeding mechanism. A six-inch screw was used inside a seven and one-half inch tube. The performance of the auger, as well as the transport characteristics of the chopped

hay within the 6 $\frac{3}{4}$ -inch diameter plexiglass pipe, were studied by varying the air velocity, feed rate and moisture content of the chopped hay. Operating at 500 rpm, the feeding capacity of the auger decreased as the initial air velocity was decreased. A maximum of 5 tons per hour was fed into the system with an initial air velocity of 5956 feet per minute, while only 2 tons per hour were handled at an air velocity of 4421 feet per minute.

The moisture content of the hay had little effect on the pressure drop within the transport pipe that increased as the feed rate was increased. However, the power required to feed the lower moisture chopped hay (approximately 50 per cent) was greater than the power required for the higher moisture hay. With an initial air velocity of 5487 feet per minute and a feed rate of 3 tons per hour, the horsepower required to

teed the lower moisture hay was 2.25 compared to 0.48 for the higher moisture hay. Although the power required to feed the lower moisture hay appears to be high, the enclosed auger

shows the most promise of the feeding mechanisms used with the laboratory system.

Project R-16

Application of Energy for Control of Insects

A laboratory apparatus was constructed and a series of tests conducted to determine the time-temperature-exposure factor related to mortality of alfalfa weevil adults and eggs. Based upon data obtained a machine was constructed for field studies. The field studies were designed to determine the effects of 3 levels of heat at 3 periods of plant development on the alfalfa weevil population in comparison to standard insecticide applications and to determine the effect on the alfalfa plant and its yielding capacity.

The times of application were: (1) Dormant; in March before spring growth began, (2) Early; in April after approximately 4 inches of new growth had developed, and (3) Stubble; in June immediately following first harvest. Checks used were: (1) no treatment, (2) methoxychlor, 1½ pounds and malathion, 1 pound per acre ap-

plied to first growth when approximately 50 percent of the tips were infected, and (3) the same insecticide combination and rates applied to the stubble immediately following first harvest.

The results indicated that the normal insecticide and high intensity dormant flame treatments were relatively free of damage prior to first cutting whereas the untreated plots were severely defoliated. The first cutting yields indicated little difference between the normal insecticide and dormant high intensity treatments; however, flaming during early plant growth resulted in reduced yields. The second growth developed relatively free of weevil damage with best control obtained with normal insecticide treatment. Excellent weed control was obtained with stubble flaming treatments.

Project RHB-23

Development of Equipment and Improved Methods

For Harvesting Sweet Potatoes

A new method of agitation was designed for the shaker bed of the experimental harvester to reduce vibration and wear in the machine and yet maintain ease of control. Both frequency (number of bounces per minute) and amplitude (height of bounce) can readily be adjusted while digging. The

deviner has also been redesigned to reduce vibration and to simplify construction.

Work has been started on the design of a prototype harvester to employ the principles developed during this project.

Project R-18

Principles of Separating Crop from the Soil In Harvesting Root Crops

Nemagold sweet potatoes were harvested from light sandy soil in a series of tests. After two replications were harvested under very dry conditions there were heavy rains, and the last two replications were harvested with the soil moisture near field capacity. Shaker bed displacements of $\frac{1}{4}$ ", $\frac{3}{4}$ " and $1\frac{1}{4}$ ", design accelerations of 1 and 5 Gs (acceleration due to gravity) and ground speeds of 1, $1\frac{1}{2}$ and 2 miles per hour (mph) were used in all combinations.

Separation of the soil from the crop under the dry conditions was very rapid under all test conditions. Under the wet conditions a small amount of soil was carried over the shaker bed at the highest ground speed and lowest agitation rates. There was no observed difference in the effectiveness of the various displacements in effecting separation.

There was significantly greater injury to the potatoes at the higher frequencies at all displacements and all ground speeds. The difference in injury decreased as ground speed increased. This decrease in injury is probably due to the greater rate of handling soil and the reduced time of exposure of potatoes to the shaker bed at the higher speeds indicating the need for good shaker bed control.

Injury was significantly greater at $1\frac{1}{4}$ " displacement than at $\frac{3}{4}$ " displacement; with $\frac{1}{4}$ " displacement, injury was at an intermediate level.

At the lower frequency, injury increased with ground speed while at the higher frequency ground speed had no effect.

Work was continued to determine the angle of roll of potatoes on a digger chain under dynamic conditions. Two chains, one with straight bars, the other



Equipment used in determining angle of roll of potatoes on digger chain. Potatoes were fed to the device by a small horizontal conveyor, not shown, to maintain uniformity.

with alternate bars jogged (offset) up and down, were used. Both were operated at one, two and three mph and with the ends of the chain on slides and on conventional four-inch diameter rollers. The following conclusions were drawn.

With the chain horizontal, there was little agitation (tendency to bounce) when the chains were carried on slides, except at the driving sprockets. Considerable agitation occurred when the chain was carried on rollers.

There was less tendency for potatoes to roll on the jogged than on the straight chain. On the jogged chain there was a tendency for the potatoes to roll onto the straight section which passes over the sprockets where rolling was as general as on the straight chain and damage was perhaps greater due to the adjacent chain hooks. Rolling was generally greater for either chain on rollers than on slides and increased with chain speed.

With jogged chain on slides at one mph no rolling was detected on angles up to $27\frac{1}{2}^{\circ}$ and only an occasional rolling potato at 30° . At the higher speeds no rolling was detected to $22\frac{1}{2}^{\circ}$ but appreciable rolling occurred at 30° . With the same chain on rollers, some rolling was observed at 15° and quite severe rolling was noted from $22\frac{1}{2}^{\circ}$ to 30° at one mph. At the higher speeds rolling was increased at all angles and larger potatoes failed to be elevated at 30° .

Commercial Plot Thresher Redesigned

A commercial plot thresher was redesigned and rebuilt to improve safety and convenience. A platform was provided at a height for convenient feeding of the machine. An arm was provided on the clutch lever to permit the operator to control operation of the machine with his leg.

Farmstead Water Supply

This project is designed to collect farmstead water use information and apply this information in the development of improved design criteria. Major emphasis has been placed on dairy farms and household water use.

Field observations revealed a close relationship between water system capacity and labor efficiency in dairy chores. Farmers who have accepted planning advice have reported reductions of one to two man hours per day in chore time. Improved design has made it possible to increase system capacity over 500 percent while reducing the cost per gallon per minute over 70 percent.

Household water use data was collected in two suburban areas in cooperation with Johns Hopkins University. These data indicate that Hunter's Demand Curve (NBS) provides a reasonable estimate of peak household demand.

With straight chain on slides some rolling was detected at 15° with all chain speeds. Some potatoes failed to be elevated at 25° at one mph and at $22\frac{1}{2}^{\circ}$ at two and three mph. With this same chain on rollers few potatoes were elevated at the higher slopes.

This information indicates the importance of carrying the potatoes on a bed of soil on the elevator section of a potato digger and of having a horizontal bed for final separation.

Project R-20

This is a trailer mounted unit and the trailer was equipped with fenders and with tail, stop, direction and plate lights.

Project R-21

Working closely with Fire Service Extension personnel, design criteria for maximizing the fire fighting potential of individual water systems were developed. These will be used by the Rural Fire Protection Committee of the National Fire Protection Association, in a new standard on rural fire protection.

A small automatic atmospheric storage tank was built to continue the hydraulic waste removal studies. Farmers cooperating in this study continue to prefer the largest nozzle furnished them that is matched to the pump's operating characteristics. It is possible to meet nozzle base pressure requirements by improved design of the individual water system, eliminating the need for a booster pump.

Cooperative Project with Agricultural Engineering Research Division, ARS, USDA

Farm Waste Disposal

Work was continued on hydroponics as a means of removing plant nutrients from the effluent of farm waste disposal lagoons prior to discharge into streams.

A field test unit (1' x 4' x 8') was set up in addition to the greenhouse experiments. However, several problems developed and had to be worked out so that the only significant data obtained was from the greenhouse experiments. Brome and Reed Canary grasses were used in place of the Orchard and Timothy which previously had been unsatisfactory. These grasses were effective in denitrification of effluent.

A five-day detention time in the hydroponic system has shown a nitrate reduction of 79.5 percent using fescue, 70 percent using rye, 64 percent for Reed's canary and 47.5 percent for brome. These are averages of five repetitions.

A five-day detention time resulted in a phosphate reduction of 66 percent for

rye, 63.5 percent for fescue, 54 percent for Reed's canary and 60.5 percent for brome. These were also averages of five repetitions. Much higher values were obtained on some individual tests.

Grass yields ranged from a calculated 4.41 to 8.5 tons per acre with an ash content of from 1.9 to 3.1 percent. At the upper limits of tonnage and ash this is equivalent to a removal of approximately 500 lbs. of dissolved plant nutrients and trace elements on a one month, one acre basis.

Average requirements for a hydroponics system would be 2.2 acres/100,000 gal/day effluent discharge (a high rate for a farm lagoon but a good "mean" figure for small municipal sewage disposal lagoons), which gives a five-day detention time.

Cooperative Project with Agricultural Engineering Research Division, ARS, USDA

AGRICULTURAL AND EXTENSION EDUCATION

Research in the Department of Agricultural and Extension Education is devoted to gaining knowledge that will improve the effectiveness of educational programs related to agriculture, and to study of rural life and related social problems.

Teaching Reading to High School Agriculture Students

A study of vocational agriculture students in Maryland high schools has shown that their reading abilities are substantially below those normally expected. Among ninth grade students, 79 percent were not able to read at the level normally expected; 68 percent read below the eighth grade level and 46 percent read below the seventh grade level.

Among tenth grade students, 82 percent read below that grade level, 73 percent read below the ninth grade level, 61 percent below the eighth grade level and 39 percent below the seventh grade level.

An attempt was made to improve their reading abilities by instituting spe-

cial procedures as a part of the instruction in agriculture. It was hoped that these procedures would improve reading ability and also increase performance in science and social studies. Six schools used the experimental procedure; these were compared with six other schools which did not use the procedure.

Students in the experimental school showed significantly greater improvement in science; however, improvement in reading and social studies was no different from that of students in the schools that did not receive the special instruction.

Project T-10

Attrition of College of Agriculture Students

In a longitudinal study of students in the College of Agriculture, an analysis was made of those students who were in good standing academically when they resigned. During the four-year period 1959-60 through 1962-63, 252 able students withdrew, compared to 250 students who were dismissed for academic reasons.

Their reported reasons for dropping out varied: lack of funds, 43; not interested, 19; military service, 18; changed vocational plans, 17; lacked sense of belonging, 14; disliked academic subjects, 14; transferred to an-

other college within the University, 13. The remainder gave a wide variety of reasons.

Of those who dropped out, 59 planned to resume study, 46 did not, and 38 were undecided or did not respond.

The study suggested need for more counseling for able students plus the opportunity to begin agriculture courses as soon as they enter college. The latter became increasingly practical in 1964 with the new General Education Program in the University.

Project T-6

AGRONOMY

The research programs in the Department of Agronomy are concerned with the development of better crop varieties and soil and crop management practices that result in more efficient crop production. The wide range of soils and the 2.3 million acres of agronomic crops (corn, soybeans, tobacco, small grains, turf grasses, hay and pasture crops) grown in the state with a value of approximately \$125 million emphasize the size and importance of this task. Research work on crop and soil problems is conducted at the University, on the University farms and with cooperating farmers throughout the state.

Breeding of Improved Varieties of Forage Species Adapted to the Northeast

An experiment with two cutting regimes imposed upon nine alfalfa synthetics was conducted in five states in the Northeast. Saranac, a new variety developed in New York, produced the highest three-year average yield under both cutting regimes (three and four cuttings per year) in the test conducted at the Plant Research Farm near Fairland, Maryland. Cutting the plots four times a year resulted in little additional hay yield over the three cutting schedule when the three year averages are compared. For example, DuPuits only produced an additional .3 ton of hay (12 percent moisture) when harvested four times rather than three. Other varieties in the experiment showed less

of an increase. On the other hand, in more northern states as New York cutting four times was injurious to hay production.

Data for the third and final year were recorded on twelve strains of bromegrass which were also subjected to two cutting regimes. One cutting treatment started two weeks before anthesis while the second started at time of anthesis. Over the three years, cutting bromegrass too early resulted in a reduction of yield when compared with results obtained from cutting at time of flowering. Some bromegrass strains had a yield reduction of nearly a ton.

Project B-56-i

Controlled Climate Helps To Understand Plant Growth

Environment plays a major role in the ultimate production of field crops. In the case of forage crops, as with most plants, the environment may also determine the quality of plant material produced. Considerable information

has been accumulated regarding plant response to specific climatic or environmental factors. Much of this research has been in growth chambers where conditions can be controlled. This answers specific questions but it does not

fully explain the behavior of plants in a "natural" environment.

Equipment for controlling soil temperature in the field has been in operation for two growing seasons. The degree of soil temperature control obtained has been better than expected. The temperature control throughout the soil profile to a depth of 12 inches was

within a few degrees of the desired temperature.

Plant responses under these controlled field conditions have been striking. Data such as these, along with growth chamber studies, will help to answer the complicated question of plant development as related to climate.

Project B-73

More Effective Use of Soil and Fertilizer Nitrogen

This project is divided into two studies. The first, a study of ammonium nitrogen on the growth of barley seedlings, showed that small amounts of ammonium fertilizers, even in the presence of ample quantities of nitrate nitrogen increased plant growth. On the other side of the picture, larger quantities of ammonium fertilizers reduced plant growth. The reason for this reduction in plant growth has been attributed by others to the accompanying reduction in potassium uptake which usually occurs when ammonium fertilizers are increased. However, this work showed that ammonium at these higher

levels can reduce plant growth without decreasing potassium uptake.

The second, a study of the influence of nitrogen on the lodging of corn is given in the following table.

Fertilizer N lbs./acre	Lodged Corn percent
220	43
120	31
70	8

The results show that nitrogen dominates the incidence of lodging in a very sandy soil.

The influence of potassium on lodging in this experiment was inconclusive.

Project O-57

Soil Aeration and Crop Growth

Soil aeration measurements made by the microtechnique in a land preparation experiment for corn show that aeration is adequate at all times except immediately after rains. Carbon dioxide (which is toxic to plant roots when present in large quantities) was found to be low in most air samples taken from plots used in all methods of preparing the land for corn. One of the methods included in this experiment consisted of killing the sod and planting the corn in the unplowed ground which

had a high bulk density and might be expected to have poor aeration.

Immediately following rains, soil carbon dioxide content was high (9 percent and soil oxygen content was low 11 percent). In some cases gas samples could not be extracted because of free water in the soil pores. This emphasizes the importance of soil surface drainage which would, to a large degree, prevent the saturation of the soil during and following rains.

Project O-72

Breeding for Better Corn Hybrids

Corn hybrids differ in their responses to soil productivity and thickness of planting. With the modern trend toward better soil fertilization and higher plant populations, it is necessary to classify hybrids with regard to these differences in growth conditions. Wide fluctuation in moisture supply from year to year and test to test obviously complicates this evaluation.

In 1964 at Hebron, Maryland, 28 hybrids, including 12 commercial single crosses, were compared at approximately 15,000 and 21,000 plants per acre on two fertility levels, fertilized for 100 and 150 bushels per acre, respectively. A late drought limited average yields

to 98 and 116 bushels per acre for the low and high populations, respectively. In this comparison, 25 of the 28 hybrids showed differences in favor of the higher population, and 10 hybrids had such differences in excess of 20 bushels per acre. Mean difference for broken stalks was not significant.

At College Park where severe drought limited average test yields to 48 bushels per acre, there was no significant difference between populations of 15,000 and 21,000. There seems to be no great danger of depressing acre yields by planting at the higher rate.

Project B-50

Production of Good Pasture Improved with Grain

Midland bermudagrass pastures sod-seeded with annual rye have been the highest in beef production per acre in grazing experiments during the past several years. However, results from small plot studies indicate that potential efficiency could even be higher with higher nitrogen fertilization.

Preliminary results of the first graz-

ing season indicate only a slight advantage of nitrogen levels above 200 pounds per acre with grazing steers. When 0.7 of a pound of grain was fed per 100 pounds of body weight carrying capacity, pounds of beef per acre and animal finish were significantly improved.

Project B-56-j

Wheat Breeding and Evaluation

Wheat continues to be an important crop in Maryland. Grower interest is oriented toward higher yields and stiffer straw. The breeding and evaluation work has been revised in this direction by raising the fertility level on test areas.

In 1965, nursery yields ranged up to 55 bushels per acre and drill plots up

to 54 bushels. In the latter test, high yields were accompanied by much lodging for some varieties. Little lodging occurred for Redcoat, Monon, Dual, Seneca and Tayland. Seneca had the top yield for the test (54 bu.) and Redcoat was second with 47 bushels.

Project B-66

Varietal Improvement in Barley and Oats

The important feed grains—barley and oats—are being improved for production at higher soil fertility levels. Modern varieties must stand up and produce more grain per acre. With the help of good soil fertility and a favorable season, winter oat varieties produced excellent yields at College Park. In the nursery, yields ranged from 70

to 127 bushel per acre with little lodging. In the larger drill plot tests, yields were almost as good—72 bushels (C.I. 7690) to 101 bushels (Lee). The new variety, Norline, made 97 bushels in this test. Experimental winter barley selections promise to give a lift to this crop.

Project B-67

Pasture Improvement with Sod-Seeding

Research over the past several years has demonstrated that pasture land that is not included in the regular crop rotation can be improved both in total production and quality of the forage.

In the past, major emphasis has been placed on the introduction of birdsfoot trefoil into grass-dominant bluegrass pastures. Recent findings indicate that sod-seeding of crounvetch may also of-

fer an excellent method of improving low-producing, legume-deficient bluegrass pastures. Because of its spreading habit of growth it is better adapted to sod-seeding techniques than many other species. Crounvetch, along with other perennial species, is also being evaluated for improvement of Midland bermudagrass pastures.

Project B-75

Red Clover Breeding Investigations

Available new red clover varieties were planted along with Chesapeake to compare their performance. Yield of hay, persistence, and other agronomic traits will be recorded on these varieties.

Persistence is a major problem with red clover. Stands only last for two or three years. A breeding method inter-specific hybridization, has been under-

taken in an attempt to obtain more persistent red clover strains. Seventy lines of different clover (*Trifolium*) species have been evaluated for seedling characters, self fertility, and number of chromosomes. This preliminary information will be used in order to select certain species for intercrossing.

Project B-76

Late Planting and Winter Survival in Oats

Research over the years continues to indicate that the more hardy varieties of winter oats can be planted a week to ten days later than customary in Maryland. Nursery seedings near College Park made October 10 have tolerated cold temperatures in the fall and winter as well as October 1 seedlings.

On the other hand, October 20 definitely appears to be too late. Although adequate plant stands frequently come through, yields have been lower from the October 20 seeding than those made by October 10.

Project B-85

Clay Mineralogy of Maryland Soils

The kind of soil parent material strongly influences the kind of clay minerals found in Maryland soils. This is shown in X-ray diffraction patterns of B horizon clay from the Collington as opposed to the Christiana soil. X-ray diffraction patterns of clay from the Collington soil, which developed in coarse Coastal Plain sediments of moderate greensand content, shows peaks characteristic of montmorillonite and glauconite with little or no kaolinite.

In contrast, X-ray diffraction pat-

terns of clay from the Christiana soil, which developed in fine Coastal Plain sediments with no greensand, show peaks characteristic of mica and kaolinite with no montmorillonite.

Because of these differences in clay mineralogy, the Collington soil has a higher cation exchange capacity per unit of clay than Christiana. Clay like that of the Christiana is preferred for brick making.

Project O-54

Soil Test Studies

Almost all soils contain some clay. As different clays often react differently to the applications of lime and fertilizer, it is important to know the type of clay in the soil.

A new method for separation and identification of clays by density gradient columns has been developed. These columns are made of layers of heavy liquids. The heaviest is on the bottom,

etc. When a clay is placed on a column it settles until it reaches a layer of its own density where it can settle no further.

Many different clays have different densities so this method affords a simple rapid procedure for separation and partial identification of clays.

Project O-55

Micronutrient Requirements of Corn in Important Maryland Soils

The presence or absence of micronutrients in Maryland soils is of concern to those who produce crops or raise animals.

The questions are: Is there enough of the element present? Is there too much? Or is it just right? Often relatively small additions of a micronutrient to the soil can shift the soil from deficient levels to toxic levels.

To help answer these questions in reference to copper fertilizers, immature corn plants 12" to 16" tall were

taken from fields throughout the eastern shore of Maryland. These plants were analyzed for copper. None of the plants sampled were deficient in copper and all plants sampled had a medium level of copper (10 ppm.) and many of the corn plants had high levels of 20 to 30 ppm. in the dry tissue.

These results indicate that copper fertilizers should be used only on soils known to be low in this element, and general usage is not recommended.

Project O-62

Relationship of Soil and Weather to Consumptive Use Of Soil Moisture by Field Crops

Soil moisture use by two plant populations of corn was the same in a corn experiment at the Plant Research Farm. Corn planted at 24,000 plants per acre used the same amount of moisture as at 15,000 plants per acre on Sassafras loam. Thus, moisture requirements must be expressed on an area basis rather than a plant basis.

This can be explained by the fact that energy is required to evaporate water and each acre receives about the same amount of energy from the sun

and from the warm air moving over the land. Reduction of moisture loss from evaporation and transpiration is difficult in field crops because wet, bare soils will lose about the same amount of water as soils covered with crops will lose through evaporation and transpiration. However, when the bare soil is dry on the surface moisture loss is reduced and bare fallow conserves moisture.

Project O-70

Nutrient Requirements of Orchardgrass

An understanding of the specific nutrient requirements of orchardgrass is essential for the efficient production of this valuable forage.

The first cutting from the nutrient balance experiment in 1965 averaged well over 2 tons of dry matter per acre for some fertilizer treatments. The following nutrient balance trend was noted: the best yield of grass was obtained

with 40 pounds of phosphorus, 80 to 160 pounds of potassium, and 20 pounds of magnesium per acre. A study of the nitrogen, phosphorus, potassium, calcium, and magnesium contents of the harvested forage should reveal some much-needed information on nutrient requirements of orchardgrass.

Project O-71

Nutrient Requirements of Summer Annuals for Forage

Summer annuals, such as Sudan-grass, sorghum-Sudangrass hybrids, etc., are an important source of emergency forage during the summer when less drought-tolerant species are not producing enough feed. It is important that the fertilizer requirements of the summer annuals are known so that high yielding, high quality forage can be grown efficiently.

Field and greenhouse experiments have been initiated with the following objectives in mind: (1) to determine the nutrient requirements of summer annuals for forage and (2) to determine the critical phosphorus and potassium contents in the plants necessary for maximum yields of high quality forage.

Project O-73

Use of Herbicides to Control Weeds in Forages

Observations indicate a need for herbicides in the production of summer annual forage crops. Summer annual weeds, as pigweed, lambsquarter, purs-

lane, are effectively controlled by 2, 4-D, but annual grasses germinating at the same time as the forage crop are not controlled by 2, 4-D. Tests conduct-

ed this year indicate that propazine will control weeds and did increase yields. Atrazine used as an early postemergence spray shows promise.

Fall seeded alfalfa is still subject to severe weed problems and new herbicides are being evaluated. Preliminary observations indicate that alfalfa is quite sensitive to most herbicides applied at time of seeding. Postemergence herbicides offer more promise and the ester form of 4-(2, 4-DB) is being tested against the amine form. Also under test is the herbicide Bromoxynil, which may prove more effective against a broader spectrum of weeds.

Project B-79

The Effects of Physical Characteristics of Herbicides On Efficiency and Mode of Action When Used on Corn and Soybeans

Combinations of the herbicides EPTC and atrazine gave excellent pre-emergence control of nutsedge in greenhouse experiments. Inclusion of 10 gallons per acre of oil in the spray appeared to improve control. Place-

ment of EPTC in a layer $\frac{1}{4}$ to $\frac{1}{2}$ " below the soil surface gave better nutsedge control than when EPTC was incorporated with the soil surface.

Project B-94

Seed Germination, Rhizome Development, And Control Methods of Johnsongrass

Recent tests show that germination of johnsongrass seed can vary from 2 to 54 percent. Based on this observation an experiment conducted in Queen Anne's County showed that johnsongrass seed germinated very well but trifluralin, linuron, EPTC + 2,4-D and some experimental herbicides gave excellent control of this seedling johnsongrass. Atrazine gave negligible control. The area had previously been treated with dalapon for control of rhizomes.

Seed collected this fall is being tested to determine possible factors influencing germination.

Project B-95



Increased use of silage crops has led to a study of the weed problems involved. As shown, broadleaf weeds (pigweed, lambsquarter) as well as annual grasses are problems.



Rhizomes of johnsongrass collected from two square feet. In the laboratory every one of these rhizome pieces produced at least one new shoot and some produced up to ten new shoots.

Physiological and Biochemical Mechanisms Of Selectivity of Herbicides

In soybean plants each molecule of the herbicide amiben reacts chemically with a molecule of a sugar, possibly glucose, to form an N-glycoside. This reaction may explain why soybean plants are tolerant to amiben.

One problem with amiben on many of the lighter soils is that this herbicide is readily leached into the soil, resulting in less effective weed control and possible crop injury. The methyl ester, which is less readily leached, was converted to amiben during five days exposure to soil under greenhouse condi-

tions. The methyl ester was about as active, herbicidally, as amiben.

Atrazine-prometryne combinations controlled crabgrass more effectively than atrazine alone in the greenhouse. Metabolites in corn plants were the same when radioactive atrazine and prometryne were applied separately or in combination. With barley as a test plant, the combinations did not reduce phytotoxic residues in the soil compared with atrazine applied alone.

Project B-98

Grazing Study with Lactating Dairy Cows On Summer Annual Pastures

Pearl millet has been shown to depress butterfat in the milk from dairy cows when this forage is managed as pasture. In addition, further research reveals that this forage also depresses fat when it is handled as green chop. Also, supplementing the pearl millet forage with 10 pounds of hay did not prevent the drop in butterfat percentage.

The reason that this grass depresses butterfat has not yet been discovered, but the dairy farmer can avoid trouble with this crop by using sudangrass for his milking herd. On the other hand, pearl millet is an excellent summer annual forage for beef cattle or dairy cattle not producing milk.

Project BG-2

Cropping Systems for Dairy Farms

Maximum yields are obtained by minimizing or eliminating limiting factors. At one location, low fertility was a limiting factor and was eliminated by proper fertilization. At another, water shortage was curtailed by irrigation. Although many factors are geared toward maximum yields in our present systems of crop production, many more must receive attention. For instance, narrow row corn planting and earlier cutting of the first alfalfa growth are two of these.

Of course, yields are not the only consideration in the production of feed for dairy cattle. The physiology of the

cows and the quantity and composition of the milk produced by cows receiving the hay, grain, or silage are important considerations. For example, of the cows fed corn silage as their only forage, three of the first four cows to calve produced calves with goiters, one of which was aborted at eight months. Iodized salt was added to the ration and the problem was gradually eliminated. Consequently, it would be wise to include iodized salt in the formulas of dairy concentrates in this area, especially if any herds are fed corn silage as their sole or principal forage.

Project BG-3

Soybean Varietal Improvement

Experimental strains were tested in uniform maturity groups IV, V, and VI. N59-6972 in group VI produced more beans than either of the two check varieties Hood or Lee.

Seed quality is a problem peculiar to the Mid-Atlantic production area. Sixty soybean strains, many obtained from other countries, were screened for good seed characteristics in an attempt to obtain new breeding lines.

An experiment was conducted to determine whether or not molybdenum treatment of the seed would result in

higher yields, especially on soils which were slightly acid. Five soybean varieties were treated with two different commercial mixtures of molybdenum and grown at two locations at pH levels of 5.4 and 6.4. There were no differences in bean yields due to the seed treatment. The check plots produced as well as the plots which had the molybdenum treatment. There was no difference due to location, and no variety benefited from the molybdenum seed treatment.

Project B-43

Midland Bermudagrass Hay Evaluated

The high production capability of Midland bermudagrass in Maryland has been demonstrated during the past ten years. In addition to producing superior yields of dry matter in small plot fertilizer trials, this excellent summer-growing grass, in combination with sod-seeded rye, has produced outstand-

ing beef yield on pasture.

In order to complete the Midland picture, hay harvested at different stages of growth and fertilized with different nitrogen rates are being produced and fed to steers in a standard digestion trial.

Project B-74

Forage Crop Variety Evaluation in Maryland

First-year results were recorded on 28 alfalfa varieties on the Agronomy-Dairy Research Farm, Ellicott City. From these preliminary results, Cayuga, a new variety, appears to be promising along with a number of new commercial strains of alfalfa.

Two varieties, Moapa and AS13, showed fast recovery after cutting but

produced hay yields which were below the average of all varieties. These varieties were developed for the Southwestern part of the United States. DuPuits showed excellent recovery after cutting and produced hay yields above the average of the test.

Project B-77

The Control of Weeds in Cultivated Crops, Turf, and Brush

Narrow row, untilled soybean research directed to more efficient farming, has been made possible because of new herbicides developed over the years.

Trifluralin, a pre-emergence incorporated herbicide, will often give season-long control; and linuron, another

newcomer, will give excellent control for an extended period. Other herbicides in the development stage will offer a wide range of choices in efficiency, method of application and species susceptibility. While the picture is, in general, bright, there are some dull spots. Further work is needed to de-

velop a control method for jimsonweed, morning glory, velvet leaf, and some other deep-seeded hard-to-control annuals.



Ever on the alert to protect the farmer, research personnel seed a cover crop to detect herbicide residues. The chemical in this plot has killed the small grains and will not be recommended until a better method of using it has been developed.

Increased research has brought out new corn herbicides which, in combination with atrazine or in place of it for a year or two, will effectively help control a weed population which has increased because of lack of control. An atrazine-linuron combination has controlled certain weeds better than atrazine alone.

Increased interest in granular herbicides shows that this formulation is very popular with farmers. Further research is being conducted to determine residual problems with rapid-breakdown granular particles.

One-year trials in this area indicate that adding a non-phytotoxic oil to atrazine solutions does not increase weed control when applied as a post-emergent treatment.

Project B-78



New herbicides for soybeans have effectively controlled most weeds but a few serious weed problems remain, as jimsonweed and velvetleaf.

Factors Contributing to Maximum Production In Maryland Tobacco

Yield levels have begun to go up for Maryland tobacco—mainly due to increased use of fertilizer, but also affected by increased populations and improved cultural practices. As varieties

of superior germ plasma are developed they need to be tested under a range of fertility conditions.

Under high fertility levels, Maryland 59, recently released, proved exception-

al in quality as indicated by price per pound. Also it yielded over 2000 pounds per acre when supplied with a complete

fertilizer containing 120 pounds per acre of nitrogen.

Project B-87

Don't Overlook Red Clover as a Hay Crop

Research work on red clover and red clover mixtures has, in the past, been done largely on land where little or no fertilizer has been applied. The harvests have also been made only after the crop has reached the half-to full-bloom stage of growth.

Results of Chesapeake red clover grown alone and with Clair timothy during the 1964-65 growing seasons look extremely good in terms of forage yields and quality. Yields were increased with increased fertilization and with the

addition of timothy. Harvesting at a more immature stage of growth (bud and early bloom) did reduce yields slightly, but the quality of the forage appeared to be improved with the earlier harvesting. Forage yields on the better treatments were nearly five tons per acre, making red clover a strong competitor with alfalfa. This factor becomes more important as the insect problem on alfalfa becomes more critical.

Project B-97

To Investigate the Agronomic Feasibility of Transplanting Tobacco Seedlings in Pressed Peat-Soil Cubes

The use of pressed peat-soil cubes to grow tobacco transplants is showing considerable promise.

This method allowed transplanting without water and with very little labor expended in pulling plants. However, more labor was required to grow plants so that total labor was not decreased, but the sharp labor peak at transplanting was reduced markedly.

In 1965 the use of pressed peat-soil cubes resulted in a two- to three-fold

increase in number of good transplants produced per 100 square yard bed when compared to conventional plant bed. Also, a much better control of time of transplanting was provided. In this test the cubes were transplanted on May 7th whereas conventional plants weren't ready for transplanting until May 28th.

Project B-96

Studies of Some Fundamental Physicochemical Relationships of Tobacco

Removal of residues of alternate crops grown in a rotation study resulted in a lower nitrogen content of the succeeding tobacco crop.

Late irrigation stimulated "second growth" of Wilson variety, renewed uptake of nitrogen, but less conversion to alkaloids. Catterton, due to earlier senescence, had less late nitrogen absorption but more complete alkaloid synthesis.

Maryland 59, a new variety, had one

per cent more alkaloids than Catterton or Wilson, under high nitrogen fertilization. No responses were noted to phosphorus fertilizer levels.

Delayed harvest was accompanied by sharply lower nitrogen contents in Wilson, less so in Catterton.

"Compact curing" did not affect nitrogen content but caused lowering of alkaloid content by 20 percent.

Project B-89

Factors Related to Irrigation of Tobacco

In four years out of the past ten, supplemental irrigation was needed for tobacco grown on Monmouth fine sandy loam, a soil with a moderately compact B horizon. Much of the crop

is grown on less retentive soils, on some of which responses to added water are obtained every year.

Project B-99

The Effect of Modified Cultural Practices and Environmental Control Of Curing Upon the Adaptability to Mechanization and Quality Of Maryland Tobacco

Curing environment was a much greater importance than the stage of maturity in the 1964 crop where tobacco was purposely planted late on June 29th. Late planting of Maryland tobacco occurs for an estimated 20 percent of the acreage.

Tobacco harvested in mid-September had enough days of satisfactory curing weather to cure out leaf valued at 51¢ per pound even though this earlier cut tobacco was immature in the top one-third of the plant. In contrast, the later harvested tobacco (Oct. 1st) which was very mature in the top of the plant averaged only 30¢ per pound. This

price decrease was due to poor curing environment where temperatures averaged below 65° F. while the upper half of the plant was curing.

Based on this research it would be better for the Maryland grower with late tobacco to harvest while his crop is not completely ripe in the top in order to gain additional desirable curing weather. Waiting for the plant to mature completely in the top and the resultant late housing date creates too great a risk of green colored tobacco due to cool curing temperatures.

Project B-101

Tobacco Breeding, Testing and Quality Evaluations Of Maryland Tobacco

In order to create variation so that selection would be effective, several Maryland varieties were hybridized. These varieties were also crossed with disease-resistant varieties of other tobacco types. The F1 generation of these crosses was grown in the greenhouse and additional crosses and selections were made in the segregating F2 populations planted in a field nursery. Plants with different characteristics, such as plant type and plant height, will be evaluated in the future for yield and quality and other agronomic characteristics.



A variety test located on deep sandy soil in Anne Arundel County, 1964. Plot on left is a mosaic resistant breeding line. Plot on right is the standard Wilson variety.

Replicated variety tests were conducted at three locations in Southern Maryland to study the response of the varieties and breeding lines to different soil and climatic conditions. Breeding lines with resistance to black shank or, to wildfire, black root rot and tobacco mosaic were evaluated and compared with standard varieties. Maturity, plant height, leaf number and other morpho-

logical characteristics, as well as yield, were measured. In order to obtain measures of quality, duration of burn and filling capacity (bulk density) were determined in addition to dollars per 100 pounds. These tests indicated that a variety may perform different in several locations which necessitates the use of outside test in variety evaluations.

Project B-103

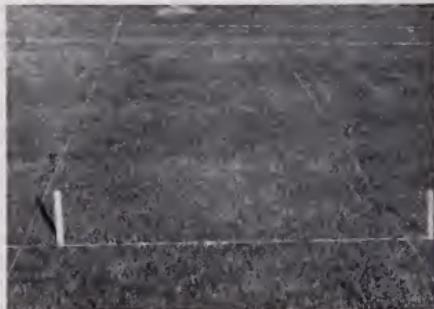
Tufcote Bermudagrass—Adaptations and Management Requirements for Turf

Preliminary research results show that Tufcote bermudagrass can be established without weed competition, resulting in faster turf coverage and higher quality turf. DMPA (Zytron, TM) crabgrass preemergence herbicide eliminated almost all weed competition with no injury to the bermuda when applied to newly planted sprigs. Methyl bromide applied to the soil before planting was almost as effective but cost much more to use.

Simazine severely injured or killed new sprigs. Bensulide (Betasan, TM)

prevented most weeds from germinating but also prevented stolon rooting. Preventing weed competition in the early establishment of bermudagrass makes a tremendous difference in rate of turf cover and winter survival during the first winter. This is especially important in Maryland where bermuda is being grown at the northern extreme of its climatic region of adaptation.

Project B-104



Dense, weed-free Tufcote bermudagrass turf (above) three months after planting and treatment with DMPA (Zytron, TM) preemergence herbicide.

Tufcote stolons without roots (left) three months after treatment of sprigs with bensulide (Betasan, TM) preemergence herbicide.

Management of Kentucky-31 Tall Fescue For Park, Playground and Athletic Field Turf

Kentucky-31 tall fescue seeded alone at three, five, seven, and nine pounds per 1000 sq. ft. has not produced a satisfactory turf for use on athletic fields. The sod was thin and unattractive during the first year of the experiment. Mixtures of tall fescue and creeping red fescue produced a fast turf cover but were soon surpassed by tall fescue-bluegrass mixtures, which produced the highest quality turf. Tall fescue-red fescue mixtures have shown little response to mowing height and

fertility differences. Tall fescue-bluegrass mixtures which contained either the Merion or Windsor variety have shown no appreciable response to extra nitrogen fertilization during the summer when cut at the 1½-inch mowing height. However, at the 2½-inch mowing height the sod has been thicker and greener where extra nitrogen was applied than where the regular rate of nitrogen was applied.

Project B-105

Development of Improved Strains of Maryland Tobacco

Three selections were made from the Maryland 59 black shank resistant breeding line. These selections and Maryland 609, another blank shank resistant breeding line, were tested at three locations in Southern Maryland. These lines were compared with other breeding lines and check varieties. One of the selections, Md. 59-1, and Md. 609 were superior in quality, but not statistically different from the Catterton variety in yield.

Seed of both Md. 59-1 and Md. 609 were increased on black shank infested soil. They were released by the Mary-

land Agriculture Experiment Station for the 1965 tobacco crop, carrying the variety names of Maryland 59 and Maryland 609.

A backcross program was initiated to incorporate tobacco mosaic resistance into Md. 59 and Md. 609 while still maintaining their high quality and black shank resistance. Mosaic resistance is also being incorporated into the Maryland varieties of Catterton, Wilson, Moore and Gertz, since mosaic is one of the most common diseases of tobacco in Maryland.

Project J-95

Field and Laboratory Soil Characterization Investigations As Related to Soil Genesis, Classification and Utilization

Water table fluctuations in some Coastal Plain soils are being studied in Talbot and Worcester Counties. In Talbot County, water table fluctuations are being studied on three poorly drained soil series. In Worcester County, water table fluctuations are being studied on soil series (all of which are developed in coarse sediments) that vary from well to poorly drained. Soil Scientists of the USDA, Soil Conservation Service, have participated by recording

water table depths at biweekly intervals.

Data from the Talbot County study show that, in 1963, water tables were highest in later winter. At that time water was ponded on many of these poorly drained soils. In the same soils, water tables were deepest in autumn, when the water tables were usually below the bottom of 5 foot measurement wells.

Project O-48

Effect of Phosphorus on Alfalfa Seedling Establishment

Diammonium phosphate, triple superphosphate, and normal superphosphate performed equally well in the seedling establishment of alfalfa. There were no detrimental effects from the more concentrated sources (diammonium phosphate and triple superphosphate). The initial advantage of band

seeding in giving the alfalfa a faster start was not reflected in yields or quality the following year. The only variable which significantly improved yields was the phosphorus rate—yields increasing with increasing phosphorus rates.

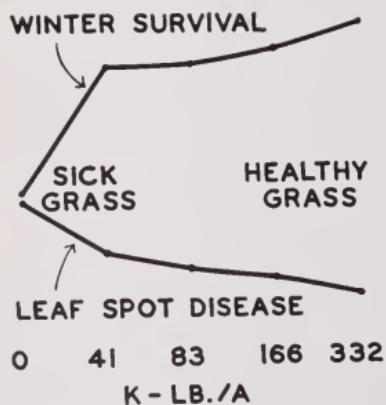
Project O-64

Nutrient Balance in Bermudagrass

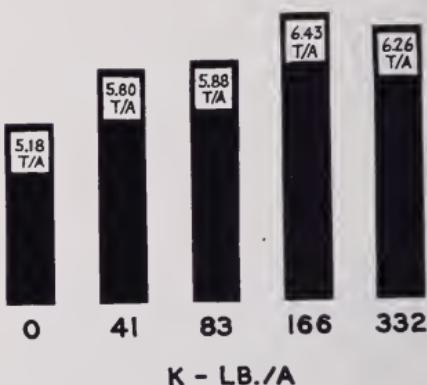
The best combination of nitrogen and potassium to apply to Midland bermudagrass at the northern limit of its cultivation was determined. Maximum yield, good nutrient content, high resistance to leaf spot disease, and improved winter survival were obtained

when 400 pounds of nitrogen was balanced with 166 pounds of potassium per acre. Nitrogen was split into four and potassium into two equal applications during the growing season.

Project O-64



As more potassium was applied to Midland bermudagrass, disease decreased and winter survival increased.



Midland bermudagrass responded best to 400 pounds of nitrogen per acre when properly balanced with potassium (166 pounds per acre).

Effect of Phosphorus and Potassium on Red Clover Production

Chesapeake has proven to be a superior red clover variety in Maryland. However, little is known about the phosphorus and potassium needs of this forage when high yields are desired. A Chesapeake red clover experiment has

been established on a soil low to medium in available amounts of these two elements.

Phosphate and potash will be applied at several rates in the following ratios: 1 to 1, 1 to 2, and 1 to 4. Forage pro-

duction will be measured in terms of yields, nutrient content, and chemically determined digestibility. Persistence of red clover will be evaluated periodically.

Roots and crowns will be sampled and studied for any effects of fertilizer on morphology and anatomy.

Project O-74

The Response of Corn to Fall vs. Spring Plowing, Broadcast vs. Plow Down Fertilizer and Fall vs. Spring Fertilization

Fall plowing and fertilization of corn may be a risky practice in Maryland. This project was initiated in the late fall of 1964 at three locations (Carroll, Dorchester, and Kent Counties). The first year's data indicated that the form of nitrogen applied in the fall (nitrate, ammonium, or urea) had very little effect upon the growth of corn the following spring. But the results did indicate that a significant amount of fertilizer could be lost during the winter if the nitrogen were plowed down in the fall of the year.

A statistical interpretation of the data indicated that corn yields (both silage

and grain) could be significantly reduced 9 times out of 10 when all but the row fertilizer was plowed down in the fall rather than in the spring. The results also demonstrated that most of the time, the fertilizer which had been plowed down was more effective than fertilizer which had been disced in after plowing. Tissue samples from the plots are being analyzed for total nitrogen, phosphorus, and potassium contents in an effort to estimate plant nutrient recovery by the corn as influenced by the various treatments.

Project O-75

ANIMAL SCIENCE

The Department of Animal Science serves producers and other members of the livestock industry, as well as consumers, by doing research in the fields of breeding, feeding, nutrition, and management with the primary objective of trying to find new or improved methods for producing better livestock more economically. Beef cattle, sheep, and swine are the animals with which the researchers work.

As rapidly as new information is found and verified, it is published in scientific journals, technical bulletins and/or popular publications. A continuous effort is made to bring new information to producers and other portions of the population in clear, understandable terms as quickly as possible. Much of this is done in cooperation with Extension Service personnel. Technical and other information is also incorporated into classroom material for both undergraduate and graduate students.

BEEF CATTLE

Herd Selection with the University's Herd

Recently, the research with the University's herds of beef cattle has dealt with the development and improvement of techniques for determining the more rapidly gaining and more efficient beef cattle. Thus the beef cattle herds were used mainly as sources of experimental cattle.

From 1950 to the present, the breeding female replacements were generally selected on the basis of their performance in the feed-lot and on their conformation and breed type. Except for the present Angus herd sire, bulls have been selected on the basis of their conformation and price, or they were on loan to the University.

With performance being emphasized in selecting females, it is logical that the sire also should be selected on similar bases if more improvements were to be made within the herd. Therefore, in 1963, the present Angus herd sire

was selected on the basis of his conformation (AA classification of 86), yearling weight (365 day weight of 1140 lbs.), and on the carcass-producing ability of his sire.

During the years 1964 and 1965 he sired 48 calves on which weaning data were collected. Thirty-four heifers had adjusted estimated 205 day weights of 449 lbs. and 14 steers 450 lbs. Yearling data have been obtained on 22 head. Fifteen heifers averaged 748 lbs. and 7 steers 801 lbs. at 365 days of age. Similar weaning data on 119 heifers and 11+ steers produced during 1955 through 1963 were as follows: average adjusted estimated 205 day weight for the heifers was 428 lbs. and for the steers 446 lbs.; and yearling weights on 115 heifers and 107 steers averaged 674 lbs. and 770 lbs. respectively. All calves born in 1955 through 1965 were creep fed and were on pasture with

their mothers. The post-weaning management of these calves differed only slightly from that of the 1964 calves.

The increase in yearling weights for both the heifers and steers and the increase in the weaning weights of the heifers by the present Angus herd sire is very encouraging from a breeding and economic standpoint.

The research program which involves the University's herds will continue emphasizing at least two main phases: (1)

the application of presently confirmed, sound methods of selection for efficient, acceptable cattle, and (2) the gathering of additional kinds of data in a search for better methods for evaluating beef animals. Basically, cattle should gain rapidly and economically; produce high quality, meaty carcasses; and possess a fully acceptable conformation both when alive and in carcass form.

Project C-41

Relationships of Measurements of Beef Cattle

A number of interesting relationships appear to be emerging not only among the sets of measurements taken within each group of steers (900 pound steers and 1000 pound steers) but also the differences among the measurements as compared between the two groups of steers.

First, comparing one group with the other, of the 306 dimensions and cuts common to the two groups, 29 differed significantly at the 5 percent level (analysis of variance) and 100 at the 1 percent level; of the 183 external, live animal, measurements, 14 were significantly different at the 5 percent level and 130 at the 1 percent level. In addition, each of the measurements and weights of cuts for each of the two groups of steers were tested to inquire as to whether or not the relationships between each pair of measurements were of a straight line (rectilinear) or curved (quadratic) nature. Within each group, many measurements were related in a curved fashion but when the results of the two groups were compared, many differences in straight and curved relationships were found to exist. The above, plus a study of the individual correlations within each group of steers indicated a number of ways in which the 900 pound and 1000 pound

steers differed, not only in actual size but also in the relationships among the various parts of the animals.

The use of factor analysis has continued to be of significance in exploring the relationships among the measurements. One advantage of this type of analysis is to find how few of a large number of measurements can be used to produce essentially the same answer as obtained with the larger number. For example, a total of 107 live-animal measurements were made of the region of the hind leg and from an analysis of these plus the weight of the rough cut of the carcass, it is found that only 12 to 16 measurements would give essentially as valuable an answer as the 107. This general type of result has been obtained in many cases but the one example will suffice.

Work has also been started on using the factor analysis to study some of the fundamental relationships of conformation between the 900 and 1000 pound steer groups. Although as may be expected from some of the comparisons cited above, there are some differences between the two groups, but a number of interesting similarities are being found relative to basic aspects of conformation.

Project C-40

Herd Analysis and Development of New Techniques For Selecting Beef Breeding Animals

Within the experimental and the other herd at the farm of a cooperating owner (Wye Plantation, Queenstown, Maryland) 89 female and 91 male calves were born. During the year, 52 females and 33 males completed feed-grain trials, and 37 females and 53 males have been put onto trial. Analyses relative to the effects of environmental factors on the data collected through the years 1954-1964 have been initiated and some are completed.

The average weaning weight of all 953 animals was 503 pounds — the males averaging about 56 pounds more than the females. Calves born during and after 1959 weighed more at weaning than those born earlier in the project. March, April, and May appeared to be the most favorable months of birth as far as producing more heavily weaning calves was concerned. Six and seven year old dams had the heavier weighing calves at weaning. The actual or estimated 365 day weight of all 625 calves averaged 859 pounds; the average difference between sexes was about 125 pounds. The heaviest average yearling weight occurred during the three

years 1962 through 1964. The improvement from the first years 1955 and 1956, to the 1961 through 1964 period was about 65 pounds. Calves born during May, June, July, and August had heavier 365 day weights than those born in other months. The effects of age of dam were rather irregular through the age range of 2 through 12 years. Until 1963, the calves were weighed at various ages near the 365th day. Age at weighing and also weaning weight were important factors in causing variations in yearling weight.

To date, the numbers of animals measured are: 156 at 28 days of age, 201 at 225 days of age, 149 at end of feeding trial, and 29 at two years of age. Most of the necessary areas have been planimetered for all animals which have been measured at the three ages: 28, 225, and 365 days. Data are cut into cards for processing as rapidly as they are received. Measurements at 28 days have been terminated, temporarily at least, until analyses of the data can be completed.

Project C-39

SHEEP

Studies of Rumenal Fermentations

In ruminants, digestible nutrients from concentrates have higher net energy values than do digestible nutrients from roughages. The major part of the energy available to the animal from any carbohydrate digested or fermented in the rumen is absorbed as the volatile fatty acids (VFA) which are produced by the microbial fermenta-

tion. The energy level of the diet (concentrate: roughage ratio) most constantly affects the molar ratios of ruminal acetic and propionic acids, the most important of the VFA. Percent propionic acid increases as the level of concentrate feeding increases, and the information currently available indicates that propionic acid can be more

efficiently utilized for energy by the host animal than can acetic acid. Thus, the VFA ratios in the rumen offer an explanation for the higher net energy values of digested concentrates.

Studies with intact animals and with various artificial ruminal preparations show that high proportions of ruminal propionate are characteristic of diets that are relatively rapidly digested. It also appears that percents propionate can be correlated with glucose concentrations in the fermentation media. These observations allow the hypothesis that glucose concentration at any particular time is a function of rate of digestion and that a more rapid digestion of high-fiber feeds may yield a more favorable fermentation in the rumen. Studies of factors affecting VFA production and the rate of digestion of carbohydrates by washed cell suspensions *in vitro* have been conducted.

Preparations containing ruminal microorganisms obtained from sheep fed all-roughage-concentrate or all-concentrate diets were used for studies of the fermentation of cellulose and more soluble carbohydrates *in vitro*. The cell suspensions and substrates were incubated in cultural media containing a variety of nitrogen sources, mineral mixtures, and B vitamins. Additions of a cellulose digesting enzyme did not increase the rate cellulose degradation by the ruminal innoculums. Changes in concentrations of the constituents of the basal nutrient medium did affect rate of total VFA production and resulted in marked changes in molar percents of the several VFA. However, additions of ruminal fluid supernatants to fermentation media resulted in VFA productions much greater than any of those observed with the basal constituent changes. Cellulose as the substrate resulted in less VFA and higher molar percents acetate than did the soluble carbohydrates (su-

crose, starch, glucose) irrespective of animal diet or additions to the fermentation media. There was no indication that any of the factors studied offered clues to a more rapid roughage digestion in the intact animal.

Studies with lambs have shown that the source of dietary nitrogen (urea versus soybean oil meal) also influences the molar proportions of ruminal VFA. Ruminal contents of urea-fed lambs on high energy diets contain higher proportions of butyric acid than do those of animals fed similar energy levels in diets supplemented with soybean oil meal. Molar percent acetate was not affected by nitrogen source and it appears that the natural protein fed in the soybean meal is the source of part of the butyrate resulting from diets containing this feed.

Feeding trials involving about 80 lambs fed rations which were isonitrogenous but varied in energy level (75 to 100 percent of *ad libitum* consumption) have been conducted to determine the effects of such feeding upon ruminal acid production, rate and efficiency of liveweight gain, and carcass characteristics. All diets contained 33 percent alfalfa meal and the crude protein content was varied from approximately 12.5 to 17 percent by varying proportions of corn and soybean oil meal. The energy restricted rations contained the higher levels of protein so that daily nitrogen intake was the same for all animals. Rates of gain were greater on the higher levels of energy feeding (92 or 100 percent) and feed conversion was most efficient at the 92 percent energy level. Carcass grades were also highest on the more liberal energy allowances but did not vary significantly between the 92 and 100 percent levels. Further energy restrictions (75 or 83 percent of *ad libitum* consumption) resulted in slower and

less efficient gains, in lower carcass grades and in greater loin-eye areas per 100 lb. of live weight or of carcasses, the latter effect being due primarily, if not solely, to the relative absence of fat in the carcasses of the energy restricted lambs.

In one feeding trial, molar percents ruminal propionate were significantly greater in the lambs fed the higher energy levels but it may be calculated from analyses of the diets as fed and of the portion refused that most of this effect was due to selective consumption of the ingredients in the diets. In the second trial, the diets were pelleted

and selective consumption was avoided. In this study, protein percent of the diets influenced ruminal butyrate, with the higher molar proportions of this acid being observed in those animals fed the restricted quantities of the higher protein diets. As has been frequently observed in other studies in the Department of Animal Science, the total concentrations of ruminal acids were highest in the lambs fed the higher energy rations but energy level *per se* did not appreciably alter the molar ratios of the various VFA.

Project C-42

Ruminal Fat Metabolism Studied

Relatively little information is available concerning the metabolism of fat in the rumen or the fate of dietary fat in post-ruminal metabolism. Studies designed to determine the effects on ruminal microorganisms on polyunsaturated, conjugated and non-conjugated fatty acids have been initiated.

Tung oil which contains large amounts of eleostearic acid (a conjugated C18 acid with four unsaturated bonds) and linseed oil (a source of C18-1, C18-2, and C18-3 nonconjugated acids) were fed to sheep in diets of varying concentrate: roughage ratios. In the first experiment, six percent tung oil or linseed oil was added to an all-concentrate diet. The tung oil drastically depressed feed intake and appeared to be toxic to the sheep receiving it. Eleostearic acid could not be detected in the depot fat of animals fed tung oil and the fat from such animals contained a higher percentage of saturated fatty acid (mostly stearic acid) than did depot fat from linseed oil fed or control animals. It is probable that the

higher degree of saturation in the depot fat reflects the low feed intake and consequent lack of fat deposition in the tung oil fed sheep. Total concentrations of ruminal volatile fatty acids (VFA) were depressed by tung oil and the acetate: propionate ratio was appreciably increased over those observed in the control or linseed oil fed sheep. Analyses of ruminal contents and feces for higher fatty acids indicated that most of the polyunsaturated fatty acids were at least partially hydrogenated in the rumen.

In a further trial, alfalfa hay was added to the basal diet and the tung oil was diluted with linseed oil to reduce the toxicity observed in the first test. Again eleostearic could not be detected in the depot fat of tung oil fed animals and tung oil resulted in an increased percentage of saturated fatty acids. When the depot fat of the controls was compared to that of the controls of the first experiment, it was noted that the addition of alfalfa hay resulted in a decreased percentage of saturated acids.

Ruminal VFA were significantly altered by the tung oil treatment with an increased acetate percentage being the major change.

Alfalfa and grass hays were compared as forage additions to concentrate diets containing linseed or linseed and tung oil for growing lambs. Tung oil markedly depressed feed consumption and rates of growth and resulted in a more saturated depot fat. As in the earlier studies, eleostearic acid was not detectable in the depot fat. In all cases, the alfalfa fed lambs had a more unsaturated depot fat than did those receiving the grass hay.

Further studies involving higher fatty acid analyses of ruminal contents and feces are being conducted. It appears that relatively little of the conjugated, highly unsaturated fatty acid of tung oil is absorbed and that it is rapidly hydrogenated and esterified into insoluble soaps. Results to date indicate that the forage (alfalfa vs. grass hay) may have more effect upon the fatty acid composition of depot fat than does the feeding of such unsaturated fats as linseed oil or tung oil.

Project C-21

Forage Moisture Content and Feeding Value

A series of experiments with forages stored as direct cut (high moisture) silages, wilted silages or field cured hays have shown that forage palatability to sheep increases with dry matter content. Weight gains, total concentration of ruminal volatile fatty acids (VFA) and molar percentages of propionic acid can also be correlated with dry matter content of the forages as stored. Feeding tests with reconstituted wet forages (water soaked cured hays) indicate that water content *per se* is not associated with palatability. It appears that moisture content affects the fermentation during the ensiling process and that fermentation change(s) is responsible for the variability in silage quality.

During the past year, barley in the bloom stage (approximately 25 percent dry matter) was finely chopped and sealed in miniature silos with (1) no treatment, (2) 70 ppm of an antioxidant dissolved in ethyl alcohol, or (3) ethyl alcohol. Palatability tests with sheep have shown that the untreated silage was the most palatable and that the antioxidant depressed dry matter

intakes below those obtained with the alcohol treated silage. Direct cut (27 percent dry matter) and wilted (35 percent dry matter) barley were ensiled and after four months were fed to sheep. Dry matter intake of the wilted silage was more than twice that obtained with the direct cut silage. Analyses of the barley silages for nitrogen, acid detergent fiber, sugar and VFA have not revealed any consistent pattern that offers adequate explanations for the differences in forage palatability.

Alfalfa and a Sudan grass-sorghum hybrid (Sweet Sioux) were stored as direct cut (ca. 25 percent dry matter) and wilted (ca. 45 percent dry matter) silages and as dry hays. Feeding experiments with ewes have shown that dry matter intakes and body weight changes vary directly with forage dry matter content and that ruminal VFA concentrations increase with dry matter intake. Detailed forage analyses which may offer some explanation for palatability differences are being conducted.

Project C-25a

New Management System for Suckling Pigs

The investigation of factors which influence supplemental feed consumption and efficient growth in suckling pigs is being continued. A slotted floor arrangement with the sow confined to a crate has been shown to reduce the amount of labor required for removal of manure which is a major labor requirement in the management of suckling pigs.

A system of shallow boxes and creep feeder replacement has been developed to induce early creep feed consumption by the suckling pigs. Baby pigs appear to exhibit less investigative behavior during the first week or 10 days on the slotted floor than in conventional solid floored farrowing pens. Increased investigative behavior is stimulated by placing uncontaminated soil in shallow boxes when the pigs reach 7-10 days of age. It has been observed that the baby pigs defecate and urinate most frequently at the back end of the pen (orientation according to the sow's position in the crate). Therefore, the boxes are placed in the front of the pen to avoid excessive contamination by the pigs. The baby pigs root and also consume measurable quantities of the soil. Over a period of one week, creep diet is gradually mixed with soil, until only creep diet is offered in the

boxes. The boxes are placed in the pens during this introductory period only when sows are removed from the crates for feeding twice daily. The investigative behavior of the baby pigs is most active during the time that sows are absent from the pens. If soil and creep feed are present continuously at the age of 7 through 17 days, the pigs show less interest. Following the introductory period, creep feeders are in place continuously in the same location as the shallow boxes had been previously.

Preliminary results based on one experiment indicate that it is desirable to remove sows from the pens twice daily for feeding. The following advantages are indicated: (1) most sows defecate and urinate in the feeding pen, thus resulting in a cleaner and dryer farrowing pen, (2) baby pigs start eating creep feed earlier, (3) the daily exercise results in less stiffness and lameness of sows after weaning, and (4) less feed is wasted by the sows.

Additional experiments will be required to confirm these observations. Study of the requirements for managing the nursing sows either continuously in the crates or with removal twice daily for feeding is also in progress.

Project C-38

Does Protein Quality in the Diet of Baby Pigs Influence Carcass Measurements at Slaughter?

The increasing practice of weaning pigs at ages of three to six weeks has focused more attention to the nutrition of pigs in this age group. Diets formulated with the protein sources of only corn and soybean oil meal have produc-

ed satisfactory performance when fed as creep diets to suckling pigs or as the only source of nutrition in early weaning diets. Measures of performance most frequently obtained have been growth rate and feed efficiency to 8

weeks of age and the same criteria to a market weight of 200 to 210 pounds. Little information is available concerning the influence of feeding simplified corn-soybean oil meal diets early in the life of the pig on subsequent carcass measurements.

Experiments have been conducted and are now in progress to evaluate the carcass excellence of pigs fed different creep and starting diets. Control diets providing protein from corn and soybean oil meal are fed during the suckling and weanling phase of growth. The experimental diets include dried skim milk, fish meal, or a combination of these two in addition to the corn and soybean oil meal. The diet formulations have the effect of altering the total amount and ratios of the essential amino acids, with particular attention to three amino acids; namely lysine, methionine, and tryptophan. The latter three are most frequently marginal in corn-soybean oil meal diets. The pigs are all fed standard diets from the time they weigh 50 pounds until they are slaughtered at 200-210 pounds live-weight. At the time of slaughter such measures of carcass excellence as backfat thickness, loin eye area, and percent of liveweight represented by the four lean wholesale cuts (hams, loins, picnic shoulder, Boston butts) are obtained.

Experimental diets are analyzed chemically for amino acid composition. The newly developed techniques for this analysis make it possible to define more clearly differences in protein quality contributed by various dietary components.

Preliminary analyses of the data now collected suggest that the inclusion of 10 percent dried skim milk in creep and weaning diets reduces backfat 0.1 to 0.15 inch, increase loin eye area 0.50 to 0.75 square inch, and increases lean cut yield 1.0 to 1.5 percent when pigs are fed to market weight on diets containing minimal protein levels. The average daily gain was essentially the same; however, the composition of that gain, by standard measures of fatness or leanness, was different.

The amount of variation encountered in carcass characteristics due to litter and seasonal influences requires that additional experiments be conducted to develop significant data. These findings will be necessary to make valid recommendations to swine producers regarding diet formulations for baby pigs if maximum pork carcass quality is to be achieved.

Project C-35

Fish Flavor in Pork Related to Higher Unsaturated Fatty Acids

Previous work in the Department of Animal Science and other places has indicated that feeding high levels of fish meal to finishing pigs reduces the firmness of the fat and imparts a fish-like flavor to the pork. It has also been demonstrated that the oil component of the fish meal is the fraction responsible for these effects.

The application of a new chemical technique, gas-liquid chromatography, has now made it possible to identify the particular fatty acids in the oil fraction which produce this effect. Pigs were fed diets containing 0 percent, 0.4 percent, 0.6 percent, 0.8 percent, 1.0 percent, 1.2 percent, or 1.4 percent, menhaden fish oil. The conventional finish-

ing diets did not include any other fish products. Taste tests were conducted on samples of loin muscle from each of the experimental animals. Fish flavor was detected in pork from pigs fed diets containing 1.0 percent, 1.2 percent, or 1.4 percent fish oil until they reached 200 pounds live weight. Removal of fish oil from the diets when pigs reached 175 pounds live weight resulted in fish flavor detection only at the 1.4 percent level of feeding. Fish flavor was not detected when the oil was removed from the diets when pigs reached 150 pounds live weight.

The higher unsaturated fatty acids 20:5, 22:5, and 22:6, both singly and in combination, increased directly in outer backfat, inner backfat, loin mus-

cle, and liver tissue with the increasing levels of fish oil. Similarly, as the fish oil was removed from the diets at the two pig weight levels, 150 pounds and 175 pounds, less of all three of the fatty acids was detected in the tissues. These three acids, characteristic of fish oil, but not of the other dietary components or normal body synthesis, were the only ones that increased in the tissues directly in proportion with increased dietary fish oil levels. It appears that the physical characteristics of soft fat and fish taste in pork from swine fed high levels of fish meal is the result of incorporating the unsaturated fatty acids 20:5, 22:5, and 22:6 into the fat tissue.

Project C-33

Basic Studies of Swine Ovarian Function

Environmental influences on reproductive efficiency in swine are not completely understood. Variability in litter size is a constant problem of the swine producers. Litters of less than six or seven pigs do not return the costs of production while litters in excess of 12 or 14 pigs are difficult to raise with a satisfactory degree of uniformity.

Ovarian activity for the production of eggs to be fertilized during the estrus cycle is a basic determining factor of litter-size potential. The ovarian production of estrogen and progesterone, hormones which influence the reproductive process, is also involved in the survival of fertilized eggs and resulting embryos during the gestation period. Ovarian activity in the live animal is difficult to study; therefore, little information is available concerning hormone production based on direct evidence. It is difficult to determine the effects of environmental influences such as nu-

trition, on ovarian function in the absence of similar direct observations.

A surgical technique has been developed to make direct observations on ovarian activity in live female swine. Surgical access to the ovaries permits observations of the ovary relative to potential egg production in a given estrous cycle and egg production during the previous cycle. More significantly, the technique allows the collection of ovarian venous blood and uterine arterial blood. Chemical analyses of those blood collections provides an accurate evaluation of the hormone production of the intact ovary before the blood levels are altered by the liver and peripheral circulation of the blood.

It has been determined that the level of progesterone in the plasma of blood leaving the ovary is 141 micrograms per 100 milliliters on day seven of the estrous cycle, rises to 223 micrograms on day 11 and declines to 141

micrograms per 100 milliliters on day 13 of the cycle. Measurements of progesterone concentration per ovary or per gram of luteal tissue (the main progesterone producing component of the ovary) in the same animals indicated that these measurements are not the most accurate indicators of ovarian progesterone secretion. The estrogen rate was not measurable with this technique due to the low concentrations in the blood.

These experiments are providing the basis for a better understanding of the basic endocrine function of the swine ovary. The long-range objective is to determine if environmental influences such as nutrition alter basic endocrine function sufficiently to change reproductive efficiency.

Project C-34

BOTANY

The Botany Department provides for studies on the fundamental nature of plants—their classification, structure, genetics, physiology, and biochemistry. Research activities of the department include many topics of interest to practical agriculture, and its scientific publications add to the store of basic information that is improving our understanding of the living organisms. Investigations center on higher plant species as well as the micro-organisms which may aid in their growth or threaten their survival.

The Native Plants of Maryland

The study of the natural vegetation of Maryland makes one immediate contribution to the citizens of Maryland—the identification of weeds and poisonous plants as well as the usefulness of our natural plant materials. By invitation, a member of the Botany Department served on an advisory committee to the State Planning Commission; suggestions were submitted regarding parks, recreational areas, and natural areas desirable for research.

Field work in progress in Calvert and Howard Counties, Assateague Island and sand spits of the Eastern Shore, and the Patuxent Estuary will increase our knowledge of our natural plants.

The study of the Patuxent River indicates some change in the aquatic vegetation as a result of the increase in water temperature due to a power generating station; however, the area affected may be less than feared.

The study of Assateague Island began before its designation as a National Park. Any information acquired should be of use in its development.

It is expected that the county studies will give some correlation between plant species and soil types. A study of plants on the serpentine soils will attempt to explain the physiological adaptations of these plants.

Project F-12

Genetic Control of the First Division Association Of Homologous Chromosomes and Fertility in Corn

The hereditary characters are controlled by genes carried in the chromosomes. The genes located on an individual chromosome are linked and tend to be inherited as a unit. Some of the genes govern easily-identified characters. Such "marker" genes can be used

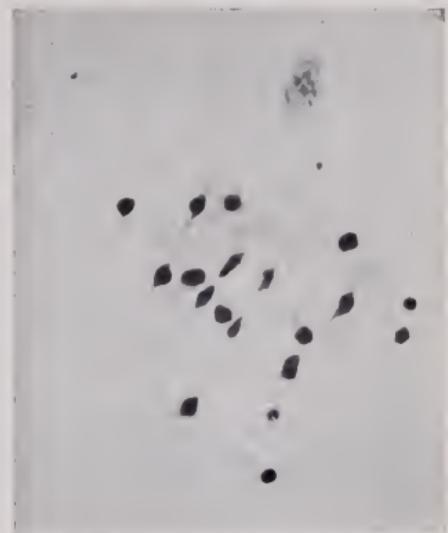
as tags in studies of the inheritance of more important although less obvious linked characters.

Chromosome 1 is the longest of the ten different types of chromosomes in corn. Corn, like most plants, has two of each kind of chromosomes. Marker

genes in chromosome 1 affecting leaf stripe, cob color and height of plant were used to locate the genetic factor controlling the association of like chromosomes required for fertility. Failure of similar chromosomes to become paired prior to the formation of the sex cells results in sterility.

X-ray induced losses of the marker genes governing leaf stripe, cob color and plant height frequently resulted in the absence of formation of chromosome pairs. Fifteen plants deficient for one or more of the marker genes and exhibiting failure of association of like chromosomes have been found. These results show that the gene governing regular formation of chromosome pairs is linked with the markers in chromosome 1.

Project F-18



Failure of association on pollen mother cell—the chromosomes are mostly scattered and unpaired. A chromosome 1, carrying the gene for chromosomal association, is absent in this cell.

The Water Milfoil Problem in Chesapeake Estuary

Water milfoil (*Myriophyllum spicatum L.*) has invaded the Chesapeake estuary with destructive results during the past half decade. Investigations during the past year have shown no drastic anatomical differences between plants grown in fresh water and those

grown at the limit of its salt tolerance. In general those plants grown in the saline habitat have smaller cells, smaller air spaces, and a larger number of included crystals than do those grown in fresh water.

Project F-19

The Change on Submerged Root Plants From Heated Discharge from Generating Plant

Boats, bottles and boots have become common equipment to the Botany Department as a team of four have invaded the Patuxent River. They are studying the area around Chalk Point Electric Generating Plant to see if the heated discharge from this plant will change the nature of the submerged rooted plants. This group has shown rather clearly that the water mass is

not homogeneous. It varies with the time of year, the stage of the tide and which side of the river you are sampling. Some fresh-water plants invade the brackish waters of the estuary. It was shown that the seeds of one species will germinate in much saltier water than it will grow and reproduce in.

Project F-20

Control of Fungal Diseases of Crop Plants

Research on the mechanism of action and selectivity of cycloheximide showed that effectiveness and selectivity could be modified by certain substitutions in the molecule. These results suggest that it may be possible to synthesize glutarimide derivatives which are more useful in plant disease control than cycloheximide.

In three years of field experiments on various vegetable crops, the new fungicide Daconil appears to be an

effective broad spectrum fungicide. Results have indicated that if this compound is registered for use and granted a label, it will gain wide acceptance by the growers and will be quickly incorporated into their disease control programs.

These studies are designed to help develop better fungicides for control of fungal diseases of crop plants.

Project J-91

Resistance to Sclerotinia Root and Crown Rot May be Found in Some Species of *Medicago*

Results of indexing 5 species and 25 varieties and selections of *Medicago* indicate that all plants tested have some resistance on a high tolerance to Sclerotinia. None of the plants tested had 100 percent mortality after one year exposure to the fungus. The range of survival was one percent for *Medicago*

platycarpa to 29 percent for *M. sativa* var. *Narragansett*. All but three of the plants tested had 15 percent or more of the plants surviving. Seed from the survivors will be indexed in 1966 with the hope that there will be an increase in the resistance to Sclerotinia.

Project J-93

Improved Root Disease Resistant Varieties Being Developed

Crosses, back crosses and reciprocal crosses between Md 59 and Md Catterton have produced progeny resistant to black shank, fusarium wilt and black root rot. A number of selections have larger leaf surfaces and one to two more leaves per plant than Md 59. Although no data has been obtained on weight of the new selections since some of them are still segregating, it is hoped that the increase in number of

leaves and the increase of leaf size will produce a heavier crop than the Md 59.

Maryland tobacco breeders in the Agronomy Department have introduced resistance to tobacco mosaic into Md 59 in the F₁ and F₂ generations. Some selections have retained the upright characteristic of the Md 59.

Project J-95

Physiology and Biochemistry of Nematode And Nematode Host-Relationships—NE-34

Studies were continued on the lipids of certain plant-parasitic nematodes and are being extended to specific host plants of these nematodes. The major

higher fatty acids of these organisms have been or are being identified and some quantitative analyses have been performed. The major sterols of *Dity-*

lenchus triformis and *D. dipsaci* were identified as lathosterol and cholesterol, and make up 0.06-0.09 percent of the dry weights of the nematodes. Variable minor amounts of plant sterols, primarily in ester form, were also found in these nematodes.

Extension of these studies will provide information on the metabolism of lipids by plant nematodes, and possibly provide clues for new avenues of approach towards their control through the use of specific metabolic inhibitors.

Project J-97

The Control of Virus Diseases of Crop Plants

The antibiotic, cycloheximide, is a highly effective inhibitor of southern bean mosaic virus synthesis in bean tissue. However, its toxicity to plant tissue precludes its practical use in virus disease control. An infectious fraction, possibly RNA or an incomplete virus particle, appears to be produced in

virus-infected plant tissue treated with cycloheximide.

These studies should aid in understanding the process of virus multiplication in plants and provide information which may be useful in the control of virus diseases of crop plants.

Project J-98

Additional Confirmation of Aldolase Inhibition by Boron And Nonessentiality of Boron for Algae

Additional evidence was obtained, with yeast (*Saccharomyces cerevisiae*) and *Penicillium chrysogenum*, that toxic concentrations of boron (B), 50 and 4,000 ppm B, respectively, inhibit the action of the enzyme aldolase. With this metabolic step in glycolysis inhibited, the growth of these fungi was inhibited.

Several species of Chlorella were previously shown not to require boron.

Cells of *Chlorella vulgaris* (Columbia strain), grown in nutrient solution with no added B, contained only 0.29 ppm of B, on a dry weight basis. This was regarded as an extremely low B value, since higher plants showing B deficiency symptoms contain 10 to 50 ppm of boron.

Project K-8-c

Forest Tree Seedlings and Soil Fungi Relationships

Virginia pine seedlings develop some resistance to damping-off caused by *Pythium debaryanum* within 50 days after emergence; and 70 day-old plants are completely resistant to damping-off although secondary roots may be infected. Histological examinations of root sections were made from plants inoculated 10, 15, 30, 50 and 70 days after emergence to determine the reason for this developing resistance. Inoc-

ulations were made by placing the roots on the surface of an actively growing agar culture of the pathogen, and root sections were made 36 hours after inoculation.

Parenchyma tissues in roots of all plants, including those resistant to damping-off, were colonized by the pathogen. A suberized endodermis, which could be detected in primary roots of 30 day-old seedlings, appeared

to restrict the advance of the pathogen, and parenchyma cells inside of the endodermis contained only about $\frac{1}{3}$ as much mycelium as those outside. In 50 day-old plants there was little mycelium in parenchyma cells inside of the now heavily suberized endodermis, although the small amount of parenchyma still outside of the endodermis was heavily colonized. In 70 day-old plants there was no parenchyma outside of the endodermis, and the prim-

ary roots were completely free of mycelium. Secondary roots on 70 day-old plants had not yet developed a suberized endodermis and were completely colonized by the pathogen. Apparently, resistance is dependent upon the formation of the suberized endodermis and is also related to the amount of parenchyma tissue outside of the endodermis.

Project J-101

DAIRY SCIENCE

Research activities in the Department of Dairy Science are directed toward problems associated with the many facets of milk production and the processing of milk and dairy products. Development of new information on the nutrition and physiology of dairy cattle is the basis for several projects. Chemical and physical properties of dairy products and their effect on quality and nutritive value are other areas of investigation. Increasing attention is given the influence of production and environmental factors on the final product used by the consumer. The matter of chemicals essential to most efficient production and their relationship to producing animals and animal food products has developed as a field of considerable activity during the past year.

Fate of Heptachlor Epoxide from Feed to Milk

A complete balance study was carried out with lactating dairy cows to evaluate pathways of absorption and excretion of heptachlor epoxide. The insecticide was fed as a residue on alfalfa hay of the magnitude resulting from the application recommended to farmers for weevil control. About 85 percent of the residue was absorbed by the cow and incorporated into body tissue and milk. After six to eight weeks a balance condition is approached, at which time the residue in milk is the result of about equal contributions from the daily feed intake and from excretion from body tissue. The excretion from body tissue is related to the quantity present in body tissue and to the rate of milk fat synthesis. Milk fat is the only major pathway of elimination. Analyses of over 50 distinct samples of body tissue, taken 100 days after the end of pesticide intake, showed a uniform distribution of heptachlor epoxide throughout the animal body. There was no apparent specific tissue acting as a storehouse of residue. Only the liver was significantly higher in residue content than other tissue. Quantitative treatment of the data accounted for over 90 percent of the

pesticide fed, suggesting that heptachlor epoxide is not metabolized in the body to some other product.

Project G-35



Complicated extraction methods are used to isolate the extremely small amounts of chemical residues in the milk of cows on experimental diets for the study of how these chemicals move in the animal body.

Persistence of Chlorinated Hydrocarbon Insecticides Shown by Study with Heifers

A new problem related to producing insecticide-free milk was uncovered in a study with first-calf heifers. The animals had received alfalfa hay with insecticide residues as a normal part of their ration up to 10-12 weeks before calving. The first milk produced by these animals contained residues much higher than older lactating animals that had received the same feed, indicating the insecticide had been stored in body tissue. This work is consistent with earlier results indicating that milk fat is the only major pathway of excretion of ingested insecticides.

Incorporation of mineral oil as a part of the regular ration was shown to

reduce the amount of insecticide absorbed by the animal from the ration.

The addition of thyroprotein to the ration was evaluated as a means of increasing the rate of excretion of insecticides stored in the cow's tissue. This treatment was found to be effective to the extent that milk fat secretion was influenced. Because of the stress imposed on the animals, it does not appear to be a practical method for eliminating insecticide contamination of dairy cows.

Project G-39

Influence of Feed on Milk Flavor

A long-term study on the effects of various feeds on the incidence of oxidized flavor in milk is being supported by a grant from the U.S. Department of Agriculture. A herd of 22 first-calf Holstein heifers has been selected for the study. Individual milks are being analyzed by various chemical and physical methods as well as by a trained flavor panel. Various dairy rations and feed supplements are being evaluated in terms of producing milk that is resistant to oxidized flavor.

Project G-34

Samples of milk from individual cows (right) are evaluated to determine the effect of ration ingredients on flavor characteristics of the milk.



Composition of Rumen Protozoal Lipids

The investigation of rumen microbial lipids has been expanded to include the rumen holotrich protozoa. This is the first detailed investigation of the lipids of these organisms. The major phospholipids were identified as phosphatidyl choline, phosphatidyl ethanolamine, and phosphatidyl ethanolamine plasmanogen. Previous work had shown that phosphatidyl choline is not present in rumen bacterial lipids. Fatty acid analysis revealed that the protozoa phospholipid contained relatively high concentrations of unsaturated fatty acids. Enzymatic degradation revealed

that the unsaturated fatty acids were located exclusively in the β position of the phospholipids. Although stearic acid was found as a constituent of the protozoa lipid, its concentration was low in comparison to rumen bacterial lipid. This observation, along with the finding of relatively high concentrations of unsaturated fatty acids in the protozoa lipid, is inconsistent with the present concept of protozoa playing an important role in the conversion of dietary unsaturated fatty acids to stearic acid.

Project G-43



A scientist uses modern equipment to learn more about the composition of milk fat and how it may contribute to our diet.

Limited Forage and Corn Silage as the only Forage for Lactation

What will be the best way to feed dairy cattle on the highly intensified dairy farms in Maryland in the future? Two approaches to this problem are being studied; feeding corn silage as the sole forage, and limiting the

amount of forage fed. While it is known that both of these systems work for one winter feeding period, their effects over three lactation periods are being studied. During the first lactation period all cows produced well,

averaging over 13,000 lb. of milk and 500 lb. of fat. Of the cows fed corn silage as the sole forage, three of the four cows to freshen produced calves with goiter. This problem was eliminated by the feeding of iodized salt. Cows receiving half of their forage as corn silage and the other half as alfalfa grown on the same farm did not produce calves with goiter. When the forage was limited to 0.9 lb. of dry matter

per 100 lb. of body weight, the cows produced less milk fat. The fat that was produced by these groups contained a higher percentage of unsaturated fatty acids. This work is done in cooperation with the Agronomy Department to assist in developing a complete system for feeding dairy cattle in areas where land is scarce.

Project BG-3

The Effect of Stage of Maturity and Planting Rate On the Nutritive Value of Corn Silage

Corn was harvested for silage from nine variety-management treatments. Early and late varieties were planted at both low rates and high rates and were harvested at about 25 and 35 percent dry matter. These silages were all compared with a medium maturing variety harvested at 30 percent dry matter. Intake and digestibility trials were conducted with Holstein steers and heifers. The heifers were used to determine

differences in intake with and without soybean oil meal supplement. Soybean oil meal increased dry matter intake over the non-supplemented group. Resulting data, when arranged and analyzed by the Duncan Multiple Range test, indicated that the low moisture silages were generally consumed in larger amounts than the high moisture silages.

Project G-52

Nutritive Evaluation of Forages

Hays have been harvested at several times during the first growth to determine the effect of rainfall on the decline in the nutritive values. Digestibility and intake studies have been con-

ducted on these hays. The data are not complete enough to determine any trends at the present time.

Project G-47

Analysis of Production and Feed Data from Dairy Records

The analysis of data found in the Maryland D.H.I.A. production records indicated a need for a different scale of evaluation of first cutting of forages. Two years work with the first cutting of forages from four locations in the state, cut at 10-day intervals starting with the initial cutting on May 1, aided in the development of a set of

standards better suited to Maryland conditions. Samples of sudan-sorghum hybrids were collected during the last growing season and analyzed to aid in the development of a more precise evaluation of these forages when fed and reported in D.H.I.A. herds.

Project G-54

Utilization of Amino Acids for Glucose Synthesis in Dairy Cows

A series of trials has been conducted to determine the effect of intravenously administered alanine on blood glucose and plasma nonesterified fatty acids concentrations in fasted, lactating cows. The data suggest a transient increase in glucose availability, presumably via gluconeogenesis. These data have served

to indicate that gluconeogenic equilibrium is a rapid enough process to allow steady state metabolic studies. To this end work has proceeded to perfect isolation and counting techniques for double label studies involving glucose-H³ and amino acid-C¹⁴.

Project G-46

The Effect of Purified Bovine Lactogenic Hormone on Blood Glucose, Fatty Acid Concentration, Milk and Milk Fat Production

Investigation of the hypoglycemic and hyper nonesterified fatty acids effects of purified bovine lactogenic hormone in lactating cows has been completed. These trials indicate a lack of effect of single acute intravenous doses of this hormone on total milk secretion and on milk fat percent. Lactogenic hormone subjected to alkaline conditions behaved like bovine

growth hormone in inducing hypoglycemia and a marked increase in plasma NEFA. Lactogenic hormone not subjected to alkaline conditions was without influence on blood glucose and plasma NEFA concentrations. These data strongly suggest similarities between growth hormone and lactogenic hormone.

Project G-46

Oral Contraceptive Effects on Reproduction Are Examined

Administration to the rat of two different oral contraceptives caused unusual reproductive alterations in the young. At adulthood these nontreated animals took a considerably longer period of time from mating until birth to produce a second generation. These

results indicate that the use of such oral contraceptives may be dangerous to a subsequent generation of animals and that further testing is necessary before widespread use in animals is introduced.

Project G-50

Determination of the Steroids Present in Bovine Ovaries, Uteri and Placenta

Thin-layer chromatographic and gas chromatographic techniques have been used to determine the various hormonal steroids and their metabolites present in cattle uterine, ovarian and placental tissue. Estrogens, androgens, progestins and adrenal cortical steroids were all

identified. The results confirm existing data for the ovary and placenta and indicate the complexity of steroid hormone regulation in a target tissue, the uterus.

Project G-50

Conversion of Progesterone into Other Steroids

Studies of the metabolism of progesterone being carried out in this laboratory show a very significant conversion of progesterone into many other important steroid hormones. Using radioactive progesterone, these conversions are being studied in small laboratory animals prior to similar determinations in cattle. Such conversions of progesterone may explain in part the changed metabolism during pregnancy,

and may account for a significant utilization of the increased amounts of progesterone present during pregnancy. The uterus has been shown to carry out these metabolic processes to a significant extent. The specific enzyme systems involved in the rabbit and bovine uterus are being examined. The physiological effects of the resulting steroids are being determined.

Project G-50



Radioactive tracers are counted by this automatic scintillation counter in a study of the metabolism of progesterone and other important hormones in dairy cattle.

Studies of Estradiol-H³ and Progesterone-C¹⁴ Incorporation into Uterine Tissue Provides Answer Concerning their Interacting Effects

In vitro studies of estradiol-H³ and progesterone-C¹⁴ incorporation by uterine tissue from rabbits and cows have demonstrated the correctness of the theory, that the action of these hormones depends upon their concentration. It has also been found that pro-

gesterone increases the incorporation of estradiol by uterine tissue, thus explaining the well known effects of the one hormone in increasing the activity of the other.

Project G-50

Site of Action of Progesterone in the Uterus Being Determined

Studies in laboratory animals, using radioactive progesterone, are demonstrating the point at which progesterone acts on the uterus. The inner glandular areas of the uterus appear to accumulate more progesterone than the outer muscular layers. This may be important in placental formation and in uterine milk secretion in cattle. Pro-

gesterone does not go into the nucleus of the cell, which suggests that changes in the basic control of cell metabolism are not involved in the action of progesterone. Pulse-chase techniques are being used to further examine these processes.

Project G-50

Pancreatic Secretion in Calves

The pancreatic duct was cannulated as published (J. Animal Sci., 23:915 1964), except polyethylene tubing was used. Stay sutures were utilized to support the cannulas after each emerged through the skin. Four Holstein, two Jersey, one Ayrshire and one Guernsey bull calves, 1 week to 6 months of age, weighing 75 to 350 lb., were used. Seventy-eight 24-hour periods of secretion have been recorded. The rations used were: young calves—milk replacer

and water; older calves—hay, concentrates and water. Secretion rate increased from 0.1 L/day (1 week) to 1.6 L/day (6 months). The daily within calf increase in secretion to 1 month of age was 0.014 L. Secretion increased during feeding, drinking and while ruminating. Greater increases occurred while eating hay as compared to eating concentrates.

Project G-39

Comparative Endocrine Effects on Isolated Calf, Sheep and Swine Fat Cells

The comparative biochemistry and physiology of the fat cells of farm animals may hold the answer to human obesity problems. Young pigs fatten readily compared to calves and lambs. Preliminary data were obtained which demonstrate differences in the hormone effects on the respective fat cells.

Pararenal fat samples were taken from calves, lambs and pigs and the fat cells were isolated by the method of Rodbell (J. Biol. Chem., 239:375, 1964). This process frees the fat cells from the stromovascular connective tissue matrix. These cells were then added to a 4 percent albumin buffer, Krebs-Ringer solution and treated with epinephrine, adrenocorticotropin (ACTH) and insulin. The lipolytic and lipogenic effects of these hormones

were measured and compared among species.

Epinephrine caused a significant free fatty acid (FFA) release with the calf and lamb fat cells, but did not affect the pig fat cells significantly. Adrenocorticotropin (ACTH) did not show any lipolytic effects on calf, lamb or pig fat cells. The lipogenic effects of insulin were demonstrated with the fat cells of lambs in poor body condition, but not with the fat cells from calves, pigs or lambs of normal body condition.

That the endocrine system affects the fat cells of the various species differently was unexpected. Precise interpretation of these results must await further experimentation.

Project G-39

Analog Computer Simulation of Calcium Metabolism

Radioactive isotopes of calcium and strontium are assumed to behave as stable calcium and strontium in the body. The isotopes, however, allow the researcher to follow the pattern of distribution or rate of incorporation of the element into the body. By dosing calves with these isotopes, and then experimentally removing each element by hemodialysis techniques, data on the tissue exchange of them has been obtained in cooperative experiments at the University of Tennessee A.E.C. Agricultural Research Laboratory.

With the assistance of Dr. A. L. Kretchmar, Oak Ridge Institute of Nuclear Studies, Cancer Clinic, a model for the metabolism of calcium has been developed using the experimental data as a guide.

The entry of calcium into bone follows two patterns. In the epiphyseal

areas, a high two-way flux exists, whereas in other sub-pereosteal areas a uni-direction pattern dominates the incorporation of each element into bone.

The new bone pool size in the epiphyseal areas amounts to about three days of growth. It is not known, however, whether growth patterns are the same during dialysis as compared to the normal.

Further experiments have been programmed and tested on the computer to allow the researchers to time the dialysis to obtain the greatest qualitative differences. Conversely, many "interesting" experiments have been eliminated by analog computer computation simulating many years of experimental work.

Projects G-37, G-39

Suspended Animation as an Animal Research Procedure

Suspended animation refers to a state of slowed life produced by hypothermia. As the temperature decreases, biochemical reaction rates slow so that organs or body parts may be without blood for several minutes without neural damage. Surgery to produce chronic vascularly isolated organs may be possible during this period. Mature sheep of 160-220 lbs. were used. They had been fasting 72 hours, shaved, anesthetized with sodium methohexitol, placed on their back between chilling blankets and heparinized. Both jugular veins were cannulated with as large cannula as possible for outflow blood. A carotid artery was used for inflow. Blood was drained out to the heart lung machine with Esmond heat exchanger and disk oxygenator at 2.2 to

4.0 L/min and was returned with a roller-type pump. Forty minutes or longer was required to chill the sheep to 6°C. Blood flow was suspended for up to sixty minutes (with heart stopped). Metabolic acidosis was a major problem due to a gradual reduction in blood drainage rate before enough of a drop in temperature was obtained. Rewarming could be completed in 40 minutes. Spontaneous cardiac defibrillation has not occurred and electrical defibrillation attempts have not been possible with our present equipment. This problem should be solved with higher powered equipment. Recovery of consciousness has been obtained.

The initial experiments in this series were conducted at the University of

Maryland Medical School under Dr. W. G. Esmond's direction. This laboratory is interested in the use of this procedure to obtain chronic vascularly isolated organs, whereas neurosurgeons believe that suspended animation will allow bloodless brain surgery. The blood from the animal in suspended

animation could be drained to the reservoir on the heart-lung machine which would allow bloodless surgery for one hour or longer. Such procedures would allow life-saving surgery which is now impossible.

Project G-37



A group of researchers and students are breaking in the new large animal surgery suite in the Dairy Science Annex. Dr. I. L. Lindahl from the Sheep Research Branch, U.S.D.A. Beltsville, Maryland, is directing a study of fetal lamb electrocardiography. His goal is to determine which drugs cross the placental membranes and affect the fetal heart.

Utilization of Cottage Cheese Whey Solids

Cream cheese was made, using low heat, non-fat dry milk solids and low heat non-fat dry cottage cheese whey solids (separately and in combination). All acidity (standardized to level of 0.5 percent) was achieved by use of bacterial culture and/or chemical (edible) acids. Flavor of products in all trials was excellent. Salt addition in the whey solids cheeses had to be reduced proportionately to compensate for the natural salty flavor of the whey solids.

Excessive body gumminess and the product shrinkage developed in cheeses when cottage cheese whey solids were used. Indications are that adjustment of processing heat treatment and stabilizer usage level will correct these body defects.

Citrus fruit drinks were supplemented with non-fat dry cottage cheese whey solids. Flavors studied were orange, lime, lemon and tangerine. Addition of cottage cheese whey solids

above 10 percent resulted in excessively acid and salty products. Sugar levels above 2½ lb. per gal. were excessively sweet. Drinks containing 10 percent cottage cheese whey solids 2 lb. sugar per gal. and the flavor levels recommended by the manufacturer

were acceptable products. Citric acid additions were necessary to mask the flavor (salty) associated with the cottage cheese whey solids. Various degrees of protein precipitation occurred in all trials.

Project G-53

Low Temperature Freezing of Ice Cream Gains Optimum Efficiency

Results of low temperature freezing studies show the value of freezing and hardening procedures which produce body and texture characteristics in the area of the threshold for organoleptic detection of ice crystals. The value of those procedures which extend to characteristics considerably below this threshold may be questioned. It is entirely possible that the usual range in

temperature between freezing and hardening temperature is much greater than needs to exist to obtain optimum body and texture characteristics.

The freezing and hardening combination should be re-evaluated in accordance with new developments to gain optimum results at the greatest efficiency.

Project G-42

ENTOMOLOGY

The Department of Entomology, continuing to seek refinements in techniques for the protection of crops and livestock from insect damage, recognizes that insect control is absolutely necessary for efficient production and improved quality. Research on fundamental problems in insect biology, physiology, classification, and insecticide toxicology is also emphasized.

Chemical Control of Insect Pests of Sweet Corn

There are two approaches to chemical insect control of sweet corn that are currently being investigated. One is the control of insect pests that attack the corn seed, and the other is directed toward the control of insects attacking the ear.

For the past few years, soil-borne insects have increased in their importance, especially cutworms. Control measures that are applied against them must not only be effective but also economical, and they must not leave persistent and dangerous residues in the soil. As a result of research in the past year, Diazinon has proven to be such an insecticide and is now being recommended for control of soil insects. In-

secticides such as Sevin, Dylox and several other experimental materials are now being tested for control of these pests.

Also several experimental insecticides are being tested for control of corn earworm, European corn borer and dusky sap beetle, all of which damage the ear. Of special interest in this work is the European corn borer. Recent tests indicate that there is a definite relationship between the time corn borer eggs are laid and the degree of infestation in the corn ear. This information is valuable in knowing how to apply insecticides properly for European corn borer control.

Project H-29-n

Chemical Control of Orchard Insects

In testing new and old pesticides in various combinations, four types of spray equipment were used. A Hardie portable was used for applying a dilute application, John Bean a 6X, RSM a 10X, and an Econ-O-Mist for applying 33X concentrate. The portable was used exclusively for testing acaricides in a block of Red Delicious where a

high population of orchard mites existed. The other three machines were used to apply complete programs of pesticides, starting with the green tip stage and continuing throughout the summer.

When the portable machine was used for the control of orchard mites, records were taken on each plot one

day before and at intervals thereafter to determine the effectiveness of the acaricides. The data show that all of the acaricides, recommended in the Maryland Spray Calendar, continue to give good control. Some of the newer materials were effective in reducing the population, and will be tested again in 1966.

The three concentrate machines were calibrated to apply the same amount of toxicant per tree or per acre as would be required with a dilute application. These machines were tested in a 12-acre block of Red and Golden Delicious trees. Close observations throughout the season failed to reveal any phytotoxicity from any of the machines or pesticides used in them. Records made on fruits at harvest showed that each of the 28 plots sprayed with this equipment averaged above 95 percent clean as compared

with 13 percent clean on the check plots. Orchard mites, one of the major pests of apples, were controlled satisfactorily with each of the concentrate machines using the standard recommended acaricides. The data did show, however, that as the concentration increased the residual from the acaricides decreased, but this decrease was not enough to be considered serious. Since experiments with concentrate sprays were started in 1962, some commercial growers in Maryland and adjoining states have converted to this type of equipment. They report satisfactory control of all pests involved, and estimate savings up to 50 percent of the over-all cost of operating the conventional type of equipment. These estimates are believed to be conservative and should encourage further use of this type of equipment.

Project H-48

Residue Studies on Organophosphorus Insecticides

In recent years increasing restrictions have been placed on the use of the chlorinated hydrocarbon insecticides in agriculture. This has led to the rapid development of the newer organophosphorus insecticides. Before materials of this type can be used on food crops the potential hazards which might be encountered must be evaluated. It is necessary to know the nature and behavior of residues resulting from the compounds sprayed on crops directly, whether these residues might contaminate the resulting food, or if forage crops treated with the compounds might yield contamination of the milk when fed to dairy animals.

Studies are under way to evaluate the influence that various Maryland climatic conditions have on the degradation and disappearance of Di-Syston and Thimet applied to the soil.

These new systemic insecticides have shown some promise in controlling aphids on spinach. Present indications are that it makes little difference when the soil is treated with either of these insecticides—if treated anytime between October and March for aphid control on winter spinach, the crop which is harvested in the spring will contain approximately the same residue. Di-Syston and Thimet are not decomposed in the soil during the colder months. Investigations are now being conducted to find out what, if anything, happens to these insecticides in the soil. Comparisons are also being made on the behavior of these compounds in soil and spinach in the summer.

Dimethoate is another new organophosphorus insecticide that has shown promise for various problems in Maryland agriculture. Studies on dimethoate

residues have continued and results have been reported for several crops. The results showed that residues on broccoli, cabbage, collards, kale, spinach, and turnip greens disappeared within 14 days. Dimethoate persisted

as long as 21 days in lima beans, snap beans, and soybeans. Peas still contained residues 21 days after application, although no dimethoate was found in the fruit.

Project H-67

Alfalfa Insects, Their Biology and Control

Work on this project has continued largely on studies of alfalfa weevil control. One new experimental insecticide appears capable of effectively controlling the insects, but is not yet labeled for use. More immediate progress has been made in more exactly determining the proper timing of insecticide applications. The best time to apply insecticides for weevil control is in the spring when most of the weevil eggs have hatched. This is usually when most of the alfalfa plants show weevil injury in their growing tips. There also appears to be some justification for altering the cutting time of alfalfa to an earlier stage than the recommended full bud stage. When presently labeled short residual chemicals are used, the reappearance of weevil larvae after spraying can come before the normally recommended cutting time and seriously delay bud formation. An earlier cutting time would eliminate this problem and it does control this second peak of larval numbers.

Two biological agents are now firmly established in Maryland. *Tetrastichus incertus*, a larval parasite, is present in the northeast counties of the state and spreading rapidly. Another larval parasite, *Bathyplectes curculionis*, is established in a few fields in Prince George's and Montgomery Counties. Present plans call for the release of more *Bathyplectes* wasps in cooperation with the USDA, and also the release of a parasite of adult weevils, *Microctonus aethiops*.

A year round survey of 10 alfalfa fields in central Maryland showed an average population level of 10 adult weevils per square foot in December, 1964. By March, 1965, overwintering mortality had reduced this number to three per square foot.

Project H-71-d

Physiology of Insect Reproduction

Studies are continuing to be made to find out where each of the complex genital organs of adult mosquitoes comes from within the larvae and how and when they develop normally. Most of the reproductive system arises from

distinct localized clusters of cells in the lower abdomen of the larvae. Each cluster forms a particular organ and differentiates at a different time either in the last stage larvae or in the young pupa. This information is essential for

a future analysis of some of the mechanisms involved in converting the genital organs of one sex into those of another sex in these insects.

Studies on how the sperm within the storage organs of the female mosquito reach the egg and how many

sperm get into an egg are continuing. These studies are complicated by the fact that when the female is forced to lay her eggs artificially very few, if any, of these eggs are fertilized.

Project H-72

The Biology of the Mosquito Vector of Eastern Encephalitis

The mosquito, *Culiseta melanura*, is known to be largely responsible for transmission of the eastern equine encephalomyelitis virus from bird to bird. Under certain conditions the virus is transmitted from birds to human beings and horses by other species of mosquitoes. Knowledge of the bionomics of the bird-to-bird vector is prerequisite to a better understanding of the disease. One of the aspects of the study involves attempts to secure more information about the feeding habits of the mosquito. It has been possible to collect sizable numbers of engorged specimens which are preserved and tested in the laboratory by means of precipitin reactions. It has been found that small wooden resting boxes were attractive to *C. melanura* females which have had blood meals.

Precipitin tests were performed on 413 engorged specimens from Dorchester County. Positive reactions were obtained with bird (275), raccoon

(20), reptile (17), and pig (5), but no evidence of feeding was found with dog, horse, deer, rat, human, or bovine antisera; 109 specimens were negative.

Studies made over a five-year period indicate that *Culiseta melanura* is a relatively rare mosquito but that in suitable habitats it develops large populations. Several swamp habitats in Dorchester, Worcester, Somerset, and Caroline Counties have been investigated. Fragmentary information about the seasonal cycle is being assembled. Although larvae are infrequently collected in quantity the occurrence of engorged females in resting boxes furnishes data on population peaks and numbers of generations. Battery operated light traps also are used in this work. The Pocomoke Cypress Swamp is one of the largest areas which produce appreciable numbers of *C. melanura*, and this habitat will receive concentrated attention in the future.

Project H-73-a

Biology and Control of Insects Attacking Tobacco

Dimethoate is now registered for use on tobacco for control of green peach aphid, the most destructive tobacco pest in Southern Maryland. Another insecticide recently approved by the government for use on tobacco against aphids is Di-Syston. Both of these insecticides are systemic, that is, they move into the plant and become a part of its living system. Approval of these materials was due in part to research conducted

at the University of Maryland on systemics for control of green peach aphid. This work is continuing and other experimental insecticides have been found to be effective for aphid control, such as, American Cyanamid 47031 and American Cyanamid 47470 and Zinophos.

There has been work under way for the past three years on the biology and ecology of the green peach aphid.

Research now being conducted indicates that many factors affect the abundance of this pest. Some of these factors are temperature, rainfall and soil fertility. Such research could pos-

sibly lead to methods of population control or prediction of heavy infestations.

Project H-74

Comparative Morphology and Physiology of Insect Blood Cells

Detailed studies on the blood cells of the wax moth were made using last stage larvae when they were busy spinning a cocoon and preparing to pupate. During this period, the number of cells in a uniform drop of blood increased from about 20,000 to 38,000 cells. These values are very misleading because at the same time the amount of blood decreases from about 68 to 19 microliters. When the blood volume is taken into consideration, it is calculated that during most of the period under study the number of circulating blood cells remains fairly uniform, averaging 1,500,000. When pupation begins, however, about 50 percent of the cells fall out of circulation. Data at the present time suggest that there is no correlation between the dividing hemocytes and changes in numbers of circulating

cells and that the fat-laden hemocytes are not derived from the non-fat-laden hemocytes.

Certain blood cells of *Galleria* phagocytize starch granules, ink, erythrocytes, and certain bacteria. Changes in the blood picture during phagocytosis have been studied in detail.

The blood cells of numerous marine invertebrates were examined to see if it might be possible to correlate the various types with the evolution of the different animals. While good correlations exist within one group, there appears to be little, if any, correlation between different groups other than the major fact that non-granular and granular leucocytes occur from the sponges to the vertebrates.

Project H-76

Metabolism of Essential Nutrients and Insecticides in Insects

Studies on the blood proteins of a number of insects have led to the elucidation of the functional involvement of some of these proteins. It was believed that the melanization phenomenon in wax moth larval blood was related to natural defense against pathogens. A study of septicemic blood from wax moth larvae infected with the bacterium, *Pseudomonas aeruginosa*, showed a marked reduction in the quantity of 5 of 16 separable proteins. The reductions were apparent only two hours after infection and pronounced by 12 hours. This phenomenon pre-

ceded any tissue pathology that could be determined microscopically. The reduction in blood proteins mimicked the reductions produced in blood *in vitro* during melanization. The dosage of bacteria was lethal in 14 hours, but it is hypothesized that a sub-lethal dose would reflect an incomplete reduction of the proteins. The importance of this work is related to the possible use of pathogens for control of insects, and the natural defenses available to the insect to resist infections.

Project H-78

Virus Control of the Fall Armyworm

Studies under USDA contract to develop nuclear polyhedrosis virus control of the fall armyworm *Spodoptera frugiperda* were initiated in the fall of 1965. A fall armyworm colony was established from field-collected larvae. The first generation was reared on natural food and all subsequent generations on a synthetic diet.

When these larvae were brought in from the field many of their disease agents were introduced with them into the laboratory. Some larvae died of uncertain causes but some displayed symptoms of bacterial infection while others had fungal and helminthic infections. By rearing larvae in separate containers the infectious organisms were nearly eliminated. For the last three months no signs of the latter two infections have been evident, while deaths with symptoms of bacterial infections are very uncommon.

On emergence the moths are confined to cages which allow for mating and the recovery of eggs. After eggs hatch the first instar larvae are placed on a synthetic diet with a camel's hair brush, a laborious process. Plans are under way to reduce the labor involved by mechanizing the filling of containers with media and the transferring of larvae.

When the larvae are six days old, the food in their container is inoculated with a suspension of the virus polyhedra in water. The larvae eating the inoculated food succumb to virus infection in five to six days. The diseased larvae are then removed and held in frozen storage until the polyhedra are required for serological or field testing.

The first field evaluations on the effectiveness of the virus in the field will begin in the early fall of 1966.

Project H-81

New Approach to Control of Insects on Cabbage and Related Crops

In Maryland there are four primary insect pests of cabbage, broccoli, kale and related crops: the cabbage looper, the imported cabbageworm, larvae of the diamond-backed moth and the cabbage aphid. Both the imported cabbage-worm and the diamond-backed moth are easily controlled with any one of a number of insecticides. The cabbage aphid has been completely controlled in experimental plots with dimethoate and under commercial conditions has responded well to a number of the phosphate chemicals.

The cabbage looper has presented a more difficult problem. Complete control has not been achieved with insecticides either in experimental plots or under commercial conditions. Only

with the use of the nuclear polyhedrosis disease has completely satisfactory control been obtained. Observations in commercial plantings over a period of several years indicate that desired chemical control of cabbage looper is obtained during periods when infections of the polyhedrosis virus naturally occur. This apparently happens at one or more times during the growing season every year in commercial plantings on the lower Eastern Shore of Maryland, while at College Park virus infections have appeared to have been present every other year.

Larvae of the cabbage looper become diseased when they eat the nuclear virus. The spraying of the virus on the food plants of the looper provides a

simple means of starting virus infections in the field. As far as known the virus organism is not affected by insecticides so that both may be applied in the same spray.

From these observations it would seem logical that a program of inoculating looper populations with the virus while treating for control of the other three destructive species would be practical. Such a scheme should be expected to give desired insect control at the most reasonable cost. Incidentally, the nuclear polyhedrosis virus of the cabbage looper is specific and will not control the other insect pests present.

In 1965 experiments were carried out on fall broccoli to obtain information

on the effectiveness of combination polyhedrosis virus-insecticide sprays. In general, results were satisfactory. Sprays containing the virus and dimethoate and some of the other phosphate insecticides gave high orders of insect control. But in this experiment even broccoli treated with the virus-dimethoate had occasional surviving loopers in heads at harvest, indicating the need for additional information on the concentration (dosage) of virus in the spray and on the frequency that applications should be made.

Project H-81

Control of Pine Coneworm

The loblolly pine industry in Maryland holds a very significant place in the economy of the State. These tall trees, grown and cut mostly on the Eastern Shore, represent jobs and investment to many citizens. Loblolly pines (*Pinus taeda* L.) grow fast and straight, and since they drop their branches, or prune themselves as their height increases, they make ideal poles and pilings.

Seedlings of loblolly pines are grown in State forestry nurseries and are sold by the Forestry Department to land owners who are planting them in increasing numbers as a cash crop.

Seeds are in great demand and are obtained by collecting cones from the crowns of trees that are cut for lumbering each fall. The cones are heated to open the cone scales, and the seeds are blown out, collected, and stored until they are needed.

Today a very severe problem of seed loss due to seed and cone infesting insects has occurred. Prominent among

these insects are the caterpillars or larvae of the moth genus *Dioryctria*. These moth larvae are given the common name of coneworms.

Several species of coneworms occur in Maryland. The most destructive one, *Dioryctria amatella* (Hulst) has three generations each year, and its habits and the methods for its control are being investigated by the University of Maryland Entomology Department.

In the early fall the female moths lay eggs on the tips of loblolly pine branches. The eggs hatch and the young larvae overwinter between the terminal needles or under the twig scales. In the spring the larvae bore several inches into the branch tips and then into the small developing cones. Loblolly pine cones take two years to grow to maturity. The first year they grow into small cones about an inch long. By July of the second year they rapidly enlarge to four inches or more in length. Until this time they are subject to coneworm infestation. After July



Three loblolly pine cones showing coneworm holes in the top one which will never develop seeds. The small cone was damaged earlier (see distal half) and it too will not develop. Healthy cone on left.

of the second year they harden and the seeds mature inside.

The loblolly pine cones grow in whorls around the branch in groups of three to five. Both the second year cones and the first year cones commonly occur on the same branches, and the small coneworms bore into them eating the center of the cone until drying drives them out and into the adjacent cone. In this manner one larva destroys one or more whorls of cones. The larvae take about six weeks to grow to the stage where they pupate. The pupae remain quiet in the cones for seven to ten days and then the adult moths emerge, breed, and lay eggs.

The biology of the coneworm is being

studied both in the field and in the laboratory.

During the spring, summer, and fall infested cones are obtained by following lumber crews and collecting the cones from the crowns of felled trees. These cones are opened, the larvae collected, and their life stage noted. These larvae are then reared to establish a laboratory colony.

First year cones are collected for food for the larvae. These small cones are cut from the tree branches, waxed, and cooled in a portable laboratory and brought back to the University. Freshness is essential since dried cones are not utilized by coneworm larvae.

Information obtained on the biology

of these moths will allow insecticide treatments to be timed so the insecticides will be present at the most vulnerable period of the insect's life.

Concurrent studies are made on predators and parasites of the moths.

The future method of growing pine seeds will lie in the area of planned seed orchards.

Since areas where trees will be cut in the fall are usually not known at the time the insecticides must be applied, the present method of collecting seeds

from private lumbering operations is a chance thing. Established seed orchards will provide the stable conditions necessary for efficient insect control. To this end experiments on systemic insecticides, which will be taken up by the tree, will be the next area of investigation in cone and seed insect control. Methods for this phase of research are being developed and preliminary studies have been initiated.

Project H-83

Host Preference of Alfalfa Weevil in Relation to

Plant Produced Attractants and Repellents

This project attempts to determine the plant components of alfalfa and related legumes that are responsible for attracting the insect to the plant and causing it to feed and to deposit eggs in the stem. To date, two active components have been isolated from alfalfa crude extracts. Both of these components are attractive to alfalfa weevil adults when offered in the presence of water. By studying the response of adult weevils to seven legumes (alfalfa, hairy vetch, alsike clover, ladino clover, red clover and two sweet clovers), it was found that all are susceptible to

adult weevil feeding. Eggs were deposited on alfalfa, to a lesser extent on the sweet clovers and hairy vetch, still fewer on red clover, and none on alsike and ladino clover. It has also been determined that the plant component that stimulates oviposition is found only in the leaves and not in the stem. It was previously determined that the adult requirement for moisture overrules host preference. This accounts for the fact that the weevil feeds on most legumes when it is "thirsty," but is quite specific when it lays eggs.

Project H-84

Study of Dimethoate Metabolism by Plants

Dimethoate is a new organophosphorus insecticide that has shown promise for solving several insect control problems in Maryland. However, before a material of this type can be used certain questions about the nature of its behavior in plants must be answered. Research under way is using

radioisotopes to evaluate the biochemical reactions that occur in the plant to inactivate and degrade dimethoate. This work should bring the time closer when dimethoate will be registered for use in several critical situations.

Project H-85

Laboratory Rearing of Biting Gnats

The increasing need for uninhabited areas as recreational sites has taken persons into undeveloped areas where previously insects went through their life cycles virtually unnoticed by man. This is particularly true of the blood-sucking insects like mosquitoes, horse flies and biting gnats (*Culicoides*). The latter are very tiny, but vicious biters in the vicinity of marshes and in wooded areas. They are small enough to pass through ordinary window screens. In the southwestern United States and the tropics they are known carriers of diseases of man and domestic animals.

A field and laboratory study of these annoying insects has been undertaken to determine where they breed, what conditions are necessary for a successful completion of their life cycle and what conditions need to be maintained in the laboratory in order to rear them in quantity for potential medical research projects. A survey of breeding sites has been made and a small colony established. A survey of the Maryland species has been started to determine which ones are most abundant and hence subject to control in inhabited areas.

Project H-86

The Control of Bird Depredation

Blackbirds have been a problem for Maryland farmers since colonial days, but in recent years the problem has increased due to changing agricultural practices, man-made changes in breeding habitats and subsequent apparent increases in blackbird numbers. Most notable have been increases in the populations of Red-wing Blackbirds, Grackles, Starlings, and Brown-headed Cowbirds. These birds are especially troublesome to corn, grain sorghum, millet, berries, grapes, and other fruits. Some growers lose thousands of dollars annually where these birds eat the crops or make them unfit for marketing.

In cooperation with nine other states and the Federal government, studies are being undertaken in Maryland to investigate all possible means of reducing blackbird damage. A survey of blackbird breeding, roosting, and damage areas has been made. Blackbirds are being trapped and banded to study their seasonal movements. The effectiveness of certain scare-devices is being checked. Future studies will involve the use of baits containing chemicals that interfere with their reproduction.

Project H-87

HOME ECONOMICS

Balanced diets, testing of cooking methods, adaptation of clothing and furnishings to needs and personal selection are a few of the almost unlimited fields of living that keep the Home Economics scientists busy. Of perennial interest to the homemaker is basic scientific research that deals with the nutritive values and flavors of foods, the climatic suitability of dress, and family well-being.

Strength Loss and Color Changes After Exposure of Drapery Fabric

Samples of twenty-nine drapery fabrics, some with a spot and stain resistant finish, some with an easy care finish, and some unfinished, were exposed at window areas with a south exposure in the Home Economics building. Exposure began in April, 1964 and was completed in April, 1965. The fabrics were attached to a muslin backing. The right side of the fabrics faced the windows. These fabrics, after one year of exposure, are being evaluated for strength loss and color change.

In April, 1965 samples of a new group of eighteen fabrics were placed at the same window area. These samples are attached to a muslin fabric. Two samples of each fabric were placed side by side, one facing the window and the other facing the room. After one year of exposure these fabric samples

will also be evaluated for color change and strength loss.

In addition to the window exposure tests, each fabric before and after five launderings and five dry cleanings is being tested in a laboratory Fade-Ometer. These tests began in September, 1964 and are continuing.

Abrasion resistance is also being measured using a laboratory abrasion machine. These tests began in October, 1964. All fabrics are being evaluated before and after five launderings and five dry cleanings. Breaking strength samples are being prepared from the abraded fabric samples. Loss in strength will be the criterion used to indicate the effect of abrasion on each of the drapery fabrics.

Project Y-2

Fertilization Effects on Broccoli

Application of nitrogen at the rate of 100 lbs. per acre resulted in decreases in amounts of chlorophyll a, total chlorophyll and carotene, and in the percentage retention of chlorophyll a and total chlorophyll.

Iron chelate applied at the rate of

15 lbs. per acre reduced the ratio of chlorophylls a to b, and decreased the percentage retention of chlorophyll b. Planting date and year effects resulted in more differences in the composition of broccoli than fertilization.

Project Y-3

Utilization of Amino Acids from Proteins Using Diet Comparisons

To meet the protein needs of the increasing world population, within the United States as well as in newly developing countries, plant proteins will be required in larger amounts.

In 1964 and 1965, 30 day experiments were conducted with 12 college women using a diet supplying 0.08 gm N/kg/day from natural foods, crystalline amino acids and wheat gluten. The proteins compared were animal (meat) and vegetable (wheat gluten). Sufficient calories for maintenance of body weight and vitamin capsules and minerals were included to make the diet adequate.

The first ten days, the protein was from natural foods with a large portion of the protein from beef (pre-experimental). After the pre-experimental 10 days, the 0.08 gm N/kg/day was supplied by a basal diet of 3.8 gm protein supplemented by synthetic amino acids (control) or wheat gluten supplemented with synthetic amino acids. These feedings followed a cross-over design.

All subjects remained in positive nitrogen balance through the test periods. The level of 0.08 gm N/kg/day was shown to be adequate.

Project NE-52

HORTICULTURE

Horticultural research programs are designed to assist both producers and consumers. High quality products are frequently the most economical to produce, and to a large degree, the small increase in cost of horticultural produce over the last 20 years is a reflection of more efficient production on the farm, in the nursery or greenhouse, and in the processing plant.

Research in progress includes studies in genetics, plant nutrition, methods of culture, storage of live fruits, vegetables, and ornamental plants, and the development of new products and processes for holding foods.

Theoretical and applied studies are under way. The theoretical studies are designed to provide information needed in the future; the applied studies are to solve existing problems. A few of the studies are summarized herein.

New Vegetable Varieties for Processors

The vegetable canning and freezing industries are confronted with the economic necessities of (1) attaining complete and low cost mechanization of raw product production, (2) continuing to improve or refine quality characteristics of the finished product, and (3) developing new products. The basic ingredient for successfully meeting these economic needs is supplied by plant breeders in the form of new varieties. By studying appropriate taxonomic features and physiological characteristics of growth and develop-

ment as they affect the process of maturation of new genotypes it is possible to identify those which possess the potential to be most useful for processing.

A limited number of new varieties of snap beans, lima beans, peas, sweet corn, and carrots possessing important and highly desirable field characteristics and finished-product quality have been found and reported to the vegetable processing industries.

Project Q-74

Controlling Weeds in Truck Crops

Truck crops have generally required much hand weeding for successful production. With modern herbicides hand weeding and cultivation can be greatly reduced, resulting in greater labor efficiency and, frequently, in greater net

returns. The use of chemicals as "agricultural tools" is truly in a new era.

Studies are conducted annually at the University of Maryland Vegetable Research Farm, Salisbury, to evaluate some 40 or more promising herbicides



Herbicides can eliminate hoeing of strawberries. Lower: Herbicide plus cultivation.
Upper: Cultivation only.

for use on truck crops. These studies involve the determination of effective rates on various weed species, crop tolerance, application techniques and the effect of various environmental conditions on herbicide performance.

For weed control in transplanted tomatoes, trifluralin has consistently given excellent results. Molinate is a promising new herbicide that has performed very well on both transplanted tomatoes and sweet potatoes. Diphenanid controls a broad spectrum of weeds in transplanted or seeded tomatoes or

sweet potatoes. DCPA, diphenanid or amiben can be used successfully on sweet potatoes if suitable moisture conditions follow application. Herbicides are being evaluated for use on cucurbits. Excellent weed control in snap beans and lima beans has been obtained with DCPA and trifluralin. DCPA has consistently given good results on cole crops. DCPA or diphenanid can be used successfully on strawberries, and chloroxuron appears promising.

Project Q-77-b

A Decade of Peach Irrigation Studies

Detailed records of soil moisture fluctuation, rainfall, and fruit growth of Sunhigh and Elberta peaches in irrigated and non-irrigated plots in a commercial orchard in Western Maryland were taken for 10 years (1955-1964 inclusive). Irrigation was needed in 7 of those 10 years. Varying amounts of water were applied, but on the whole two 2-inch applications were made in most of the seven years. The last four successive years of this decade developed into dry peach seasons—May through August—and only 1957 was closely comparable in lack of seasonal rainfall. The increase in fruit size as a result of irrigation in the seven years is summarized below:

Per cent volume increase over non-irrigated fruits

Year	Sunhigh	Elberta
1955	44	9
1957	47	58
1959	13	14
1961	11	16
1962	31	34
1963	38	24
1964	18	26

Since crops were adjusted to carry uniform numbers of peaches, the percent increase in fruit size means a corresponding increase in yield. In years when harvest occurred during dry periods, fruit color and quality of irrigated peaches was markedly superior to that of unirrigated fruits. Further, fruit size was increased over the critical minimum size below which peaches were unmarketable a total of three years out of the seven irrigated years on Sunhigh, and two years on Elberta.

One of the most unexpected results of this ten year study was found at the end of the decade. At this time the



Irrigated Sunhigh peaches (left) are 45% larger than non-irrigated (right), 1963 season. The difference was created by an irrigation of 2.5 inches 33 days before harvest, and 2 inches 10 days before harvest.

non-irrigated trees—especially the Sun-high variety—showed dead wood and general deterioration of vigor, while irrigated trees continue to thrive. This is evidence that years of deficient mois-

ture during the growing season are cumulative in effecting decline of peach trees, and thereby shortening the productive life of an orchard.

Project L-74

Chemical Weed Control in Peaches

There is a need for an effective and safe herbicide program for use in peach orchards. At the present time, no post-emergent material (for kill on contact) is cleared for use, and only one pre-emergent herbicide has clearance. To be effective, pre-emergent herbicides usually must be applied to weed-free soil. When applied in combination with a contact herbicide, no soil preparation is necessary, and the proper timing of sprays will kill existing vegetation and prevent germinating seeds from becoming established.

Some experiments conducted in 1965 on newly-planted Redskin peach trees, using a combination of a post-emergent chemical (paraquat) and a new pre-

emergent material (bromacil), gave season-long control of both weeds and grasses, with no sign of injury to the trees. The rate of application was 1 and 2 pounds per acre, respectively, in the area sprayed. Furthermore, doubling the rate of bromacil to 4 pounds per acre (in combination with 1 pound of paraquat) caused no adverse effects on the trees and they made excellent growth. Thus, it would appear that if clearance for use of these compounds is obtained, an effective and safe recommendation for weed control in peach orchards can be made for the first time.

Project L-74

Azaleas for Home and Garden

Azaleas have been an increasingly important economic crop in Maryland for both the nurseryman producing plants and the florist forcing plants into flower in the greenhouse. Because of the potentials for this plant as an indoor flowering pot plant in addition to its suitability as an outdoor landscape plant, there has been an increasing interest in producing flowering plants at all seasons of the year. Recent studies of the response of azaleas to environment have made possible better methods of production and pointed the way for individual nurserymen and florists to set up production procedures for year around flowering.

Recent work has shown that vegetative growth is most rapid at moderate temperatures and under long day conditions. Flowers are initiated most rapidly at temperatures of 65°F or slightly higher and under short day conditions. Although there has been found a wide difference in varietal response, each variety studied has been found to follow the same general trend. Following floral initiation, the flower buds are in a dormant or resting stage and need special treatment corresponding to overwintering in the out-of-doors before flowers will open in the greenhouse. This resting stage has been found to be terminated most rapidly

by storage for four to six weeks at temperatures between 45° and 55°F accompanied by a very low light intensity. High light intensity, under some conditions, tends to nullify the effects of cool temperature and a longer storage period is required at temperatures lower than 45°F.

Peat moss has been a generally accepted root medium or soil amendment for azaleas. Earlier work has shown the importance of maintaining adequate phosphorus and potassium levels when growing in peat moss. The best growth has resulted from frequent but light applications of a complete fertilizer with a high nitrogen ratio such as 2½-1-1. Excellent growth through the year has been attained by bi-weekly watering with a solution of 1½ pounds of a 25-10-10 fertilizer dissolved in 100 gallons of water.

An active variety and seedling testing and selection program has been carried on to find types of azaleas most suitable for year-around flowering in the greenhouse. Vigorous but compact growth in addition to early flower formation, rapid forcing and flower quality, size, and color are the characteristics being looked for in this evaluation.

Many azalea varieties produce vigorous long shoots with little or no lateral branching. Plants fail to make a compact growth unless sheared frequently and late shearing may result in failure to flower. Experiments have shown that two growth-retarding chemicals under the trade names of *B-Nine* (N-dimethylaminosuccinamic acid) and *Cycocel* (2-chloroethyl trimethylammonium chloride) have been useful materials for spraying on azaleas during the mid or late summer to control growth. One or more sprays of either material at a concentration of .25 percent of the active material applied at weekly intervals can be used depending on the degree of growth control desired. Results of treatments have shown that such treatments usually increase the number of flowers on each shoot which is desirable with many varieties. Some observations have indicated that growth retardants may also increase the winter hardiness of treated plants. Experiments currently in progress have been designed to test this effect of growth retardants.

Project I-74-a

Tomato Breeding

The development of machinery for mechanical harvesting of tomatoes has necessitated the parallel development of varieties suitable for mechanical handling. Early attempts to mechanically harvest tomatoes met with little success, but the improvement of machinery, changes in cultural methods, and development of new varieties has made mechanical harvesting much more feasible.

Emphasis has been placed on the development of varieties for mechanical harvesting in the breeding program at

the Maryland station. Crosses have been made between lines having desired characteristics, and an evaluation and selection program has been followed for the subsequent generations. Several promising breeding lines have resulted.

The main factors studied in this program have been vine size and set, concentration, shape, color, firmness, and crack resistance of the fruit. Firmness and resistance to cracking are especially important for a completely mechan-

ized harvesting program. The processing qualities of the tomatoes have also been considered in making all selections.

Other research in the breeding program includes development of early paste, green wrap, and dwarf types;

incorporation of jointless pedicel, uniform ripening, high acidity, and high pigment into breeding lines; and genetics of high acidity, earliness and disease resistance. Genetic studies of new mutants are also being conducted.

Project Q-81-d

Pod Setting in Snap Beans

Snap beans were grown in pots in the greenhouse and transferred to controlled-temperature growth rooms just before anthesis. Day temperatures were maintained at approximately 80°F in one room and 90°F in another, with night temperatures 8° to 10° lower in each case. The high temperature greatly reduced the setting of pods with a high percentage of blossoms dropping off in the bud stage. In two different

tests, plants at the higher temperature set only 11 percent and 3 percent of the number of pods set at the lower temperature.

The few pods set at the 90° temperature were generally crooked and contained an average of 1.1 seed per pod compared to 4.5 at 80°. All varieties tested to date have responded in a similar manner.

Project Q-77



Effect of temperature on pod setting in snap beans. Plants from growth rooms maintained at 80° F (left) and 90° F (right) during the day; night temperatures were 8 to 10 degrees lower in each case.

Developing a Variety and Process for Freezing Tomatoes

Tomatoes were one of the first products to be preserved by canning and for many years they were the leading canned vegetable. Ordinarily tomatoes for canning are peeled and packed whole into the can. As a result of the necessary sterilization treatment, such whole tomatoes cannot be used for salad purposes, but only for cooking.

Many attempts were made to freeze tomatoes whole or sliced to provide a high quality tomato for salad use during the winter season. Recently with the development of new varieties that retain their wholeness and firmness, it has been possible to freeze sliced tomatoes so that they retain their shape reasonably well upon thawing.

At this station work was done not only to find a suitable variety and process for the manufacture of frozen slices, but similar work was done to find a suitable variety and process for preparing canned sliced tomatoes and canned tomato wedges. The results of this study indicated that several of the new varieties could be packed as frozen slices if frozen extremely rapidly with liquid nitrogen spray. Canned slices of the same varieties were superior to the frozen in texture and color but had a typical canned tomato flavor as compared to the frozen slices which retained a fresh tomato flavor.

Project Q-58-m

Portable Shear-press Developed

Previous work in this laboratory resulted in the development of the shear-press which is capable of measuring rheological quality of many kinds of food products. One of the major uses of such an instrument is to determine the optimal time for harvest. Since it is necessary for these tests to be done in the field where a power source may not

be readily available, a modified portable shear-press was developed which operates on compressed air. Except for the fact that it requires manual accumulation of pressure, results have indicated that the qualitometer will provide the same results as will the full-size shear-press.

Project Q-58-r

Fertilizers for Narrowleaf Evergreens

The fertilization practices for narrowleaf evergreens have been developed on a practical experience basis. This has been true for plants in the field under nursery conditions and those in landscape plantings. Evergreen plants increasingly are being grown by nurserymen in containers for greater ease in

handling and selling. A study has been made of the influence of three different levels of application of nitrogen, phosphorous and potassium to the soil on the growth of the Hatfield yew (*Taxus media* cv. *Hatfieldii*). The plants were grown in 10-inch containers using a uniform media of equal parts

of peat and sand. The fertilizers were supplied in liquid form at regular intervals.

This study showed that there was an increase in growth from the application of either nitrogen, phosphorus or potassium alone. When used in combination, as is the usual practice in commercial fertilizers, the most significant increase in growth was produced with those solutions that supplied all three nutrients at the rate of 224 parts per million (ppm) nitrogen, 75 ppm phosphorus

and 135 ppm of potassium. This would be supplied by using chemical materials that would supply 3.2 oz. of nitrogen, 2.3 oz. of P_2O_5 and 2.2 oz. of K_2O to 100 gallons of water applied at two-week intervals during the growing season. This would also be supplied with a fertilizer of a 3-1-2 ratio.

An analysis of the foliage showed that the nutrient content of the foliage fluctuated with the nutritional content of the soil.

Project I-79-m

Proper Curing of Sweet Potatoes Alleviates Losses from Harvest Injury

Holding sweet potatoes at a high (90-95 percent) relative humidity at 85°F for five to seven days following harvest has been shown to result in best subsequent storage quality. During this "curing" period suberized tissues are formed over injured areas, lessening dessication during storage. With the advent of mechanical harvesting of sweet potatoes, injury at harvest may increase, and seriously affect the condition of the stored crop. To determine the effect of such injuries at harvest, three varieties of sweet potatoes were intentionally subjected to injuries simulating those obtained in mechanical harvesting, and then "cured" at low (50-60 percent R.H.), medium (70-80 percent R.H.), and high (90-95 percent R.H.) humidity for seven days at 85°F. All lots were stored at 60°F, and at high humidity following curing.

Weight loss during curing and storage and the condition of the sweet po-

tatoes after two months of storage were greatly affected by the humidity of the curing room. Much less weight loss occurred at the high humidity, and there was much less difference between the injured and control lots when cured under high humidity conditions. Injured roots cured at low humidity showed severe surface scars, making many unmarketable. When cured at high humidity there was much less evidence of the harvesting injury. Injured sweet potatoes when cured at high humidity had less weight loss and were in better market condition after two months storage than were non-injured sweet potatoes cured at low humidity.

Proper curing and storage conditions will lessen the deleterious effects of injury at harvest and will be most essential if sweet potatoes are harvested mechanically.

Project Q-77

Rapid Objective Measurement of Peach Quality by Volatile Analysis

The aroma of food is due to the production of very small quantities of volatile chemicals such as aldehydes, alcohols, and ketones, which, when inhaled,

produce the sensation of smell and greatly affect flavors. These chemicals are produced in such small amounts that, until the recent advent of gas-li-

quid chromatography, extremely large samples had to be used to obtain quantities sufficient for any type of analysis. During the last three years, gas-liquid chromatography has been used as an "electronic nose" in studies to determine the presence of, and changes in, volatiles produced by peaches of different varieties and maturities.

The volatile chemicals produced by peaches were separated into six "groups" by gas-liquid chromatography and the relative amount of each was related to various quality factors. Only five minutes were required for an indi-

vidual analysis. Four "groups" increased in quantity with maturity and ripening, while two tended to decline. A ratio of two groups, one of which appeared during ripening and one which disappeared with ripening, gave good correlations with harvest maturities, graded series of firmness, and number of ripening hours which indicates that gas-liquid chromatography may prove to be a new technique for rapid, objective measurement of peach quality. As yet, no identification of the chemicals involved in peach aroma has been attempted.

Project L-79-f

POULTRY SCIENCE

In the United States poultry meat and eggs are two of the most inexpensive forms of animal products. This is in sharp contrast to the situation in many foreign countries where poultry is considered a luxury item to be enjoyed mostly by the rich. The explanation for the phenomenal efficiency with which the poultry industry operates is in large measure the result of intensive research and the willingness of the industry to accept and apply research findings. The research carried on by the Poultry Science Department of the University of Maryland is of both a fundamental and a practical nature, but always problem oriented.

Effect of Protein Adequacy on the Efficiency of Selection For Early Fattening of Turkeys

Two lines of turkeys have been selected for rate of growth during the two- to eight-week growing period under two different feeding regimes. During the selection period, one line has received an adequate protein diet while the other line has received a diet which has been inadequate in methionine and lysine. The objective is to determine whether or not lines so selected will eventually differ in body composition when they are both fed the same diet. No measure, though, has as yet been made of the carcass composition of the birds of the two lines.

The companion investigation using *Coturnix* quail is continuing, and five generations of selection have been completed. There has been a gradual in-

crease in four-week body weight in both the full-fed line and the line which is selected for growth rate while fed a lysine-deficient ration. There has been little or no change in the percentage growth rate from two to four weeks of age. In comparison to the random-bred control line, the full-fed line now is heavier and has a more rapid early growth. The deficient line has a 20 percent slower growth rate during the two to four-week period. There are now a sizable number of individuals in the deficient line which grow as fast as the average of the other lines. Results indicate that it will be possible to establish a line of *Coturnix* which will grow well on lysine-deficient rations.

Project M-400

Relationship of Vitamin E to the Enlarged Hock Disorder in Turkey Poult

Vitamin E is currently considered to be one of several nutrients needed in turkey-starting rations to protect against "enlarged hock disorder," a type of perosis to which turkeys are particularly susceptible.

Recent tests at Maryland, in which young turkeys were fed diets which

were severely deficient in vitamin E, have consistently failed to show any relationship between this vitamin and enlarged hocks.

Project M-63

Studies with Leucosis

Leucosis continues to be the most active killer of poultry. This project is an attempt to determine the chemical basis for genetic differences in susceptibility to leucosis, with the hope of finding a simple blood test for use in selecting the most resistant birds at an early age. A large number of enzymes in serum have been studied; their level has been measured in resistant and suscep-

tible lines. Only one, cathepsin, appears promising at this point. However, matters are complicated because not all resistant and susceptible lines differ from each other in cathepsin level. Considerably more information is needed on this subject before any conclusions can be made.

Project M-303;NE-51

Metabolic and Nutritional Studies on Microorganisms Important to the Poultry Industry

Although three well-known fatty acids—stearic, palmitic, and oleic—constitute one-half to three-fourths of the total fat in poultry intestinal round worms, another unidentified lipid material is present in significant amounts. These lipids can be used to study the metabolism of the worms, which may suggest methods to control the infection. Likewise, a continuing study of lipid content and lipid synthesis in PPLÖ microorganisms (pleuropneumonia-like organisms) may contribute to the control of this widespread poultry disease.

A comparison of the lipid metabolism of free-living protozoa with that of par-

asitic protozoa will increase our fund of basic knowledge. *Tetrahymena*, a free-living, single-celled protozoan, synthesizes a non-saponifiable complex pentacyclic alcohol from squalene, and in this respect, is plant-like. In contrast, animals synthesize cholesterol from squalene. However, *Tetrahymena* is animal-like, in that it synthesizes linoleic acid, the form of linoleic acid found in animals. This interesting organism is being used in further studies of factors affecting lipid synthesis.

Project M-58

Lipid Metabolism of Fowl Spermatozoa

Fowl sperm do not survive freezing for long periods as do bull sperm. To determine why freezing impairs the sperm viability, a study is being carried out on how freezing, storage and other factors affect the lipid composition of poultry sperm. In the neutral lipids of normal sperm, cholesterol is the largest component, about 70 percent, while wax esters (13 percent), and glycerides make up the rest of these lipids. Pal-

mitic, stearic and oleic acids are found to the greatest extent—together they constitute 77 to 83 percent of total fatty acids and free fatty acids. However, oleic acid is highest in the fatty acids of the wax esters (56 percent compared with 33 to 35 in the total fatty acids and free fatty acids). These wax esters are of interest since they are not usually found in animal tissues.

Project M-59

Calcium Requirement of Young Turkeys

For many years nutritionists generally recommended that feeds for young turkeys should contain about 2 percent calcium to insure good growth and bone development. Considerable information has accumulated recently, however, indicating that the calcium requirement is actually considerably lower than had been thought, and also that large excesses should be avoided. In recent tests at Maryland, with the Mary-

land Medium White turkey, it has been found that 1 percent calcium in turkey-starting rations consistently gave maximum growth with complete freedom from rickets. The results indicate that for practical operations, where it is desirable to provide some "margin of safety" over minimum requirements, 1.2 to 1.4 percent calcium should be entirely adequate.

Project M-206

Chick Red Blood Cell Transketolase as an Index of Thiamine Nutriture

Nutritionists are continually searching for simplified laboratory techniques which may be utilized in the rapid evaluation of the nutritional status of animals and poultry. From studies with other animals, it is known that a thiamine deficiency is associated with a reduction in carbohydrate metabolism. This decrease has been shown to be due to a loss of transketolase enzyme activity.

Three chick studies have been conducted with purified diets containing 4, 11.5, and 25 percent added fat and six levels of added thiamine varying from 0.88 to 1.98 mgs. per kg. in all combinations. Increasing the dietary fat level consistently reduced the thiamine requirement for growth. In two studies, the average dietary thiamine required (mgs./kg. of diet) to support maximum

growth was 1.94, 1.84 and 1.77 for diets containing 4, 11.5 and 25 percent added fat, respectively. As the dietary thiamine level increased, red blood cell transketolase activity increased; transketolase activity plateaued at a dietary thiamine level of 1.93 mgs. per kg. of diet. Data have been obtained which will permit the quantitation of the thiamine requirement for the metabolism of fat and carbohydrate calories. These results suggest that transketolase activity is a sensitive index of thiamine nutriture of the chick.

The results of a preliminary hen study indicate that red blood cell transketolase activity can also be used to evaluate the thiamine nutriture of the laying hen.

Project M-207

Use of Chick Bio-Assay in Measuring Specific Amino Acid Availability

The *total* amount of a nutrient contained in a given feedstuff is tending to become inconsequential to the present-day nutritionist. Of paramount importance are the *available* nutrients

contained in feedstuffs; that is, the proportion of the total which is readily assimilated and utilized by the animal. Studies concerning the determination of available methionine and lysine con-

tents of feed ingredients have been continued; these amino acids are considered to be of most critical importance in practical rations based on corn and soybean meal.

Available methionine content of soybean meal (50 percent protein), corn gluten meal (60 percent protein), yellow corn and menhaden fish meals averaged 0.73, 1.74, 0.196 and 2.14 percent, respectively. Available lysine content of soybean meal (50 percent pro-

tein), corn gluten meal (60 percent protein) and menhaden fish meal averaged 3.15, 0.81 and 4.52 percent, respectively. The influence on methionine availability of high storage temperatures in atmospheres of oxygen and nitrogen has been studied. In addition, work has been conducted with high protein soybean meals in cooperation with the University of Maryland Agronomy Department.

Project M-208

Effect of Protein Level and Amino Acid Balance On Voluntary Food Consumption

The combined or singular additions of excess quantities of lysine, methionine, phenylalanine and histidine to chick diets resulted in marked depression in voluntary food consumption and growth rate. Similar additions of leucine, glycine and threonine resulted in no reduction in food intake or growth rate. The combined addition of all seven amino acids partially alleviated the adverse effects observed when the combination of lysine, methionine, phenylalanine and histidine was fed. These results suggest that certain amino acids in excess create a type of physiological hardship associated with their metabolism, while the presence of certain others in excess results in no apparent metabolic hardship. The combined addition of certain members of these two classes of amino acids appears to alleviate to some degree the metabolic hardship referred to above—possibly by influencing absorption rates or resulting in blood levels which may be conducive to protein formation rather than catabolism of the excess circulating amino acids.

Studies have been conducted to determine the effects of temperature and methionine level on growth rate and voluntary food intake. At severely deficient methionine levels, chicks maintained at reduced temperatures consumed more total food and gained more rapidly than chicks maintained at normal temperatures; less dietary methionine, as percent of diet, was required to support maximal growth rate of chicks kept in the cold. Despite this, more dietary methionine was required per unit gain in the cold environment even when growth was limited by dietary methionine level. This suggests that suboptimal caloric intakes increase the amount of the first limiting amino acid required per unit gain. Excess dietary methionine (0.75 - 1.5 percent) resulted in greater growth depression among chicks maintained in the cold. Growth depression observed from excess methionine was directly related to the calculated amounts of total sulfur amino acids metabolized per gram of body weight gain. Serum amino acid assays revealed little differences in levels of

amino acids, except for methionine as the level of added methionine ranged from 0 to 1:5 percent; the level of serum methionine was increased approximately 24-fold as the dietary level was raised. Temperature appeared to exert only limited effect on serum amino acid levels despite the markedly greater amounts ingested by the chicks maintained at low temperature.

Protein levels varied from 22.5 to 45.0 percent in chick diets in a study designed to investigate the effects of protein on voluntary food consumption,

growth rate, body composition and serum amino acid levels. As protein level was increased, absolute food intake was decreased as well as food consumption per unit gain. Protein level exerted no apparent effect on weight gain until after a level of 33.7 percent was reached. Preliminary observations regarding serum amino acid assays suggest relative differences in the rate of metabolism of amino acids and possibly a tendency for the organism to minimize total free amino acid levels.

Project M-209

Determination of Amino Acid Requirements Of Growing Broiler Chicks and Laying Hens

Two hen studies, one involving the individual feeding of 168 birds, have been conducted to determine the requirement for available lysine for egg production. Diets containing less than 0.492 percent available lysine failed to

support satisfactory egg production, egg weight, feed consumption or body weight. Serum protein levels increased with increasing levels of lysine.

A simplified lysine requirement equation for laying hens is as follows:

$$L = 0.38W \pm 8.61 \Delta W + 10.63E + 467R - 168.1$$

in which

L=Avail. lysine requirements/hen/day
in mgs.,

W=Average body weight for period in gms.,

ΔW =Average daily change in body weight in gms.,

E=Average grams of egg produced/hen/day, and

R=Ratio of avail. lysine to energy expressed as mgs. of avail. lysine per metabolizable kilocalory.

A series of studies designed to determine the requirement of the chick for lysine as a function of those factors which are known primarily to influence that requirement is in progress. These factors will include body weight, body

composition and rate of body weight gain. The lysine requirement will then be expressed in terms of milligrams of lysine required per bird per day under defined conditions rather than as a percent of the diet. *Project M-210*

The Effect of Folic Acid Supplementation On Hatchability of Eggs and Quality of Offspring

When Maryland Medium White turkey hens were housed in individual laying cages and fed rations of differing folic acid contents, it was found desirable to supplement breeder rations to insure a level of at least 0.5 mg. folic acid per pound of feed.

During 1964, as little as 0.3 mg. of folic acid per pound of feed produced satisfactory hatchability, with the excellent quality pouls, whereas in 1965 this

level of folic acid produced poor hatchability and very weak pouls. Evidence of deterioration in poult quality was also noted with 0.43 mg. folic in the ration in this test. Such differing results might be due to varying stores of folic acid in hens at the beginning of the laying season, and they emphasize the need for adequate folic acid level in the growing ration of breeder stock.

Project M-62

Applied Broiler Nutrition Studies

Practical broiler studies have shown that increasing the protein level above that needed to supply all the essential amino acids has resulted in improved feed conversion with little or no increase in weight gain; this is accompanied by a slight reduction of body fat. Supplementation of low protein diets with specific amino acids has failed to result in similar improvements in feed conversion. Although slightly better feed conversions are obtained as protein levels are increased to extremely high levels (34 percent), our data suggest that metabolizable calorie protein ratios should be approximately 60, and 68 to 70 for broiler starting and finishing rations, respectively.

The reduced energy intake observed when protein levels are increased above those needed to supply essential amino acids is thought to be due to an effect on physiological appetite.

Male and female broilers exhibited similar reductions in energy intake at protein levels above those needed to provide adequate levels of amino acids for growth.

A linear program for formulating least-cost broiler rations has been developed at the University of Maryland.

Containing 65 restrictions, it is quite detailed and includes a calculation of essentially all nutrients required by poultry. At present, considerable effort is being given to formulating rations for feed manufacturers on the Eastern Shore of Maryland to determine whether or not the more detailed program is of greater perpetual benefit than the usual program which involves approximately 30 restrictions. This formula service by the University is also used for formulating rations to be used in experimental work by feed manufacturers.

During the 50th substation trial, the opportunity was taken to compare broiler formulas which have been fed at the Maryland substation during the previous 15-year period. When using these formulas with the same rapidly growing chick and improved methods of housing, management and disease control, broilers reached the same weights in 1965 in eight weeks as were reached in 1950 in ten weeks. In the same study, however, it was shown that feed cost per unit gain has been reduced from 9.73 to 8.09 cents per pound of broiler when compared with one formulated by the use of a least cost linear program.

Project M-66

Quality Retention in Poultry Meat As Influenced by Methods of Processing

Blood volume (the total amount of blood in a bird) is valuable and basic information for many studies on poultry. Studies carried out here tested the common dye method with a radioactive iodine method.

We injected a radioactive compound in the blood, allowed it to mix and then used a counting device to determine the dilution. The results with this method compared well with previous results and more information was collected on the amount of plasma trapped in between red blood cells as well as total blood volume.

With the knowledge of the total blood volume of the chicken, we then were able to determine the amount of blood lost during slaughter, the amount removed with the viscera, and the amount remaining in various parts of the cut-up chicken.

About one-third of the weight of the liver is blood. There is no significant difference in the amount of blood in the breast and drumstick, but the gizzard contains very little blood after the bird is slaughtered. The order of greatest to least amount of blood remaining in var-

ious parts was as follows: liver, lung, kidney, spleen, head, back, heart, neck, wing, drumstick, thigh, viscera, breast, feet, fathers, and gizzard. About one-half of the total blood of the bird is removed after it is slaughtered.

Under this project another aspect of product processing was studied. We wanted to determine if spoilage would occur at a different rate if poultry was put in vacuum heat-shrunk packaging. Consumers have complained about the way poultry is packaged and they have stated that they would be willing to pay as much as two cents a pound more if they could have better packaging. In vacuum heat-shrunk packaging, the appearance is considerably improved over a bird that is sloshing in bloody water in a loose plastic bag. We found that in heat-shrunk packaging there was no disadvantage as far as spoilage is concerned, and that there was less drip loss in the package. According to our tests, there also seemed to be less odor when the package was opened and there was a considerable improvement in appearance of the packaged bird.

Project M-100

Eliminating Bruising of Live Broilers In Transportation from Farm to Processing Plant

Bruised poultry coming into processing plants on the Eastern Shore costs each processor from \$500 to \$1500 a week. This is one of the most important factors that is causing poultry to be lowered in grade. This project was initiated to determine the causes and methods of reduction of these bruises.

It has been established that most bruises occur when poultry is moved

from the farm to the plant. Studies here on a limited scale indicate that possibly males are bruised more easily than females but this may be due to adjustment of processing machinery. At the present time, there is a considerable amount of work being done on lighting of birds during the growing period. Birds grown under low light conditions and normal lighting do not differ in the

amount of bruising as indicated by limited studies here.

In order to do controlled studies on bruising, a standard method of bruising must be established so differences can be studied if they exist. Therefore, we have worked on an instrument and calibrated it to determine the minimum amount of energy required to bruise a chicken. Results with a falling body

were not satisfactory for us, so we have made a new instrument in which the amount of energy delivered and the surface area of the force can be varied. Now it is possible to study, under laboratory conditions, bruising differences based on sex, light intensity, strain, muscle thickness, skin thickness or other factors.

Project M-61

Measurement of an Enzyme in Blood Serum As an Aid in Improving Egg Production

The object of this long-term study just completed was to see if egg production can be increased by selecting only for the level of a chemical in the blood. The chemical chosen was alkaline phosphatase. During the early part of the study evidence was obtained that there are genetic and phenotypic correlations between the level of this enzyme and egg production. It was also observed that there were significant differences between families in enzyme level. The critical phase of the whole study was a selection experiment in which the only parents selected were those with a high level of alkaline phosphatase in their serum as six-week-old chicks. The results of this selection were

a three-fold increase in alkaline phosphatase level, and more important, a significant increase in egg production. The high line which resulted also had slightly increased egg weight, slightly thinner shells, and lower fertility. The results suggest that alkaline phosphatase level in serum could be an aid for a breeding farm in selecting for high egg production. This might make it possible to obtain some measure of the genetic potential of males for egg production. Only a very small proportion of the males can normally be kept, and even a poor measure of the potential for egg production would be better than none.

Project M-32-m

Effects of Gonadal Hormones on Embryonic And Postnatal Bone Growth in Chickens

The effect of sex hormones on the bone growth of immature birds has been investigated. Androgen, the male sex hormone, combined with the estrogen, the female sex hormone, was injected into chicks at three weeks of age and at weekly intervals thereafter. In one trial, androgen alone at a relatively

high level or combined with estrogen, resulted in a depression of the 9-week body weights and a reduction in the shank length. Estrogen alone caused lower body weights in only the females. Analysis of the data indicated that the reduction in body weight was related to the reduction in shank length.

In another trial, estrogen alone caused a reduction in 9-week shank lengths in both sexes but caused no change in body weight. Androgen at a very low level combined with the estrogen treatment produced increases in body weight and decreased shank length. Blood se-

rum calcium and phosphorus analysis suggests that the basic physiological cause for the reduction in shank length is independent of calcium and phosphorous deposition in the bones.

Project M-64

Perception and Preference of Chickens for Different Colors

Much of the early literature about chickens would indicate that their eyes are not adapted for differentiating colors. Work was initiated to determine if chickens could recognize different colors and if they showed any preference for certain colors.

Results of the investigation give a positive answer to both of these questions. Hens not only were able to rec-

ognize nests of different colors, but some birds definitely showed a preference for certain colors. The order of color preference observed leading with the most attractive, is pink, light blue, black, gray, green, dark red, orange, brown, dark blue, yellow and buff or tan.

Project M-55

VETERINARY SCIENCE

The Department of Veterinary Science investigates animal disease problems of economic importance to producers of livestock and poultry. The relation of animal disease to human health presents a situation of increasing importance. Cooperative work on certain research projects is conducted with agricultural and medical divisions of the Federal Government.

Respiratory Diseases of Poultry

In attempts to evaluate the importance of antigenic variants of infectious bronchitis, two field isolates produced the disease in birds immune to the most common type. The response of the immune birds was found to be related to the dose of virus administered. Future bird challenge studies to determine the occurrence of variant strains of infectious bronchitis must recognize this finding.

Studies of infectious bronchitis immunity indicated that parental immunity was not sufficient protection during the first few days of a baby chick's life. In addition, 3 of 13 flocks of chickens vaccinated at 10 days of age with combined Newcastle - Bronchitis vaccine

were found to be susceptible to infectious bronchitis when challenged at eight weeks of age. The B₁ Newcastle Disease virus did not interfere with the immunizing ability of an infectious bronchitis vaccine in another trial. Field breaks of infectious bronchitis appear to be due to poor immunization. The significance of the variant strains has not been determined.

A total of 232,287 blood samples were checked as part of the *Mycoplasma gallisepticum* (MG) control program. A MG exposure program is being undertaken at the request of the poultry industry.

Project D-52 (NE-5)

Studies on Zoonotic Arboviruses

There were at least nine cases of eastern equine encephalomyelitis (EEE) in Maryland horses during 1965. Seven of these were laboratory confirmed cases and EEE virus was isolated from five of seven equine brains submitted for examination. An outbreak of EEE in pheasants and chukar partridges occurred at Willards, Maryland, resulting in the loss of over 800 pheasants and approximately 1100 chukars. Rapid diagnosis of the disease, together with a quarantine and slaughter

of all sick birds prevented a possible epizootic.

Of 36,000 mosquitoes (22 species) collected in the Pocomoke Cypress Swamp, 80 percent were *Culisetta melanura*. Of the 112 viruses isolated, 25 were EEE and one was western equine encephalomyelitis. At least 50 of the unidentified viruses appear to be EEE virus. No virus was isolated from any of the small animals, although over 500 blood samples were tested.

Project D-57

Mastitis in Cattle

General herd surveys on 1,631 dairy cows in Maryland showed that 75 percent of the cows were infected with pathogenic bacteria in one or more quarters. The percentage of type of bacteria present in positive quarters was Staphylococci 49 percent, Streptococci 44 percent, and other types 7 percent.

From the bacteria isolated in the survey work, over 800 Staphylococcal cultures have been collected and their biochemical characteristics determined, in preparation for bacteriophage typing of Staphylococci in Maryland dairy herds.

A comparison between the Wisconsin Mastitis test, the Modified Whiteside test and the direct microscopic test for counting leucocytes was made to determine the most feasible bulk milk test for use in Maryland. The Wisconsin Mastitis test was recommended to the Maryland Mastitis Council because (1) it employs an objective method for measuring leucocytes, (2) it is the least time consuming, and (3) the results compare favorably with the direct microscopic method.

Project D-58

A Study on *Mycoplasma gallisepticum* Infection in Poultry

Mycoplasma gallisepticum infection in poultry is known by such other names as "air-sac" infection, chronic respiratory disease (CRD), PPLO (pleuropneumonia-like-organism) infection and infectious sinusitis. The more inclusive name, mycoplasmosis, has been proposed to include all manifestations of this disease complex. As a basis for meat inspection practice in the slaughterhouse, as well as for the control and eradication of disease in the poultry flock, a rapid and accurate method of diagnosis is needed. A study on this problem has been carried out with a twofold purpose. On the one hand, the investigation was conducted to determine the extent and frequency with which the disease is disseminated from the respiratory system to other organs, particularly to edible portions of the fowl's body. On the other hand, it was desired to determine the correlation between the older and more time consuming method of isolating PPLO by culture and the more rapid and newer method of diagnosing the disease by direct staining of tissue smears or suspen-

sion with direct examination under the microscope and fluorescent staining technique.

The investigation was carried out by inoculating a group of 20 six-week-old turkeys with air-sac lesion tissue containing PPLO. At intervals from 3 to 30 days postinoculation, two turkeys were selected from the inoculated group at random and killed for autopsy and removal of selected organs for bacteriological examination. The prepared culture sediment and tissue suspension were subjected to fluorescent staining for final identification of *M. gallisepticum*. By either or both methods, *M. gallisepticum* was identified in the respiratory system of all inoculated turkeys. Lung and air-sac were the tissues of choice for diagnosis of PPLO. In a total of 200 tissue suspensions, including 10 from each of 20 turkeys, 71 were found positive for *M. gallisepticum*. In a total of 9 (45 percent), the organism was identified in such other organs as the brain, kidney, thoracic wall muscle and spleen. In all inoculated turkeys, heart, liver and pooled leg and wing

muscles were negative. Infection was found in the blood stream of five turkeys between the 11th and 21st days postinoculation. Diagnosis by culture and direct tissue smear were in agreement in a total of 58 (67.6 percent) of 71 positive tissue samples. Fluorescent staining alone detected PPLO infection

in 69 (81.1 percent) of the positive cases. By the use of culture media, an additional 13 (18.3 percent) infected tissues were detected that were negative to direct smear with fluorescent staining.

Project D-59

Leptospirosis in Cattle

Large-scale surveillance for detection of leptospirosis has been done only on herds located on the Eastern Shore of Maryland.

Although studies on the effectiveness of cross-protection with leptospiral-serotype strains are, as yet, incomplete, results indicate that one experience with a leptospiral serotype develops resist-

ance effective enough to protect against subsequent infection with a second serotype. Passive immunization did not protect hamsters unless some antibody was already present. Exposure of passively immunized hamsters to a serotype other than that used to immunize did not protect.

Project D-62 (NE-40)

Study of Bovine Respiratory Diseases

During the year, several suspected outbreaks of shipping fever (SF) and infectious bovine rhinotracheitis (IBR) in Maryland cattle were reported. Shipping fever, IBR, and bovine enteroviruses were isolated from clinical specimens and antibodies against SF-4, IBR and adenoviruses were detected in serum samples.

Calves experimentally infected with hemadsorbing enteric virus developed diarrhea when given the virus *per os*. A very mild respiratory illness and di-

arrhea were observed in calves inoculated with the virus intranasally, either alone or in combination with *Pasteurella multocida*. A mild respiratory illness was developed in calves experimentally infected with reovirus type 1 using various routes of inoculation. The effect of virus was not potentiated by *Past. multocida*. Experimental infection of calves was also conducted with a bovine adenovirus. The virus produced a mild respiratory illness in these calves.

Project D-63

Propagation of Infectious Laryngotracheitis Virus of Poultry In Tissue Culture

Cultivation of disease-producing viruses in tissue culture has several advantages over propagation in embryonating chicken eggs. Chiefly, cytopathogenic changes are more rapid and cell culture medium is less complicated than chorioallantoic fluid of the embryo. Infectious laryngotracheitis (ILT) virus

was propagated in young chicken kidney cells supported by Eagles Basal Medium with 0.25 percent trypsin. The rate of viral replication was studied and it was determined that ILT virus in young chicken kidney cell culture exhibits a latent phase of 10 to 14 hours followed by a growth phase

reaching a peak at about 30 hours. Although a slight increase in eluted virus in tissue fluid could be detected at 24 to 30 hours, appreciable quantities of intracellular virus were not released until the 48th hour after inoculation. This is attributed to spontaneous rupture of the somatic cell wall. (The length of the latent period and maximum virus titer were directly proportional to the concentration of virus originally introduced in cell cultures.)

The site of intracellular growth was studied by applying fluorescent staining technique to cover-glass monolayers removed from Leighton tubes at various intervals postinoculation. (Immu-

nofluorescent stain was prepared by conjugating immune serum from chickens vaccinated against ILT with fluorescein isothiocyanate. Such stain possesses marked affinity for viral protein (antigen.) Viral antigen was first detected 6 hours postinoculation as a diffuse ring of fluorescence in the inner periphery of the nucleus. After 12 to 18 hours, viral antigen amounted to fluorescing particles most concentrated in the inner nuclear periphery. After 30 hours, viral antigen was concentrated in the nuclear inclusion body. A second cycle of virus replication was initiated 42 to 48 hours after inoculation.

Project D-64

Studies on Bovine Lymphosarcoma

Regular monthly blood examinations of the previously inoculated calves were continued.

In addition, 4 new one-day old calves were inoculated intravenously with blood plasma isolates or with sonicated extracts (SE) of lymph nodes from calves previously inoculated. One of these four calves has already developed a positive blood reaction and an hypertrophy of the lymph nodes of the sub-maxillary area.

To date, study reveals that, as the age of the animals increases, the blood reaction becomes more significant in its constancy at the positive level for some animals and in the increase of the num-

ber of animals to the suspicious and positive levels. Among the positively reacting calves, the group of those inoculated with tissue culture material is on top with 100 percent reaction and those administered SE of bovine lymphosarcoma, second, with 50 percent of the animals reacting.

On the basis of a new series of inoculations performed on more than 800 mice in order to duplicate results obtained in previous trials from inoculated calves and mice, there is accumulating evidence toward confirmation of previous results.

Project D-65

Toxic Substances Produced by the Mold, *Stachybotrys atra*

Stachybotrys atra, growing in litter, may produce toxic substances causing lesions in the mouth and crop of chicks. This toxic material has been concentrated by the use of column and thin-layer chromatography. The aim of the

project—to obtain a pure chemical compound in a quantity sufficient for identification — has not yet been achieved.

Project D-66



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1964-1965

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FINANCIAL STATEMENT - JULY 1, 1964 TO JUNE 30, 1965

<i>Federal Funds</i>		<i>Hatch Amended</i>	<i>Regional Research</i>	<i>Title II Agr'l Mkt'g</i>	<i>Forestry</i>	<i>McIntire-Stennis</i>
<i>Appropriations 1964-1965</i>						
TOTALS		\$484,001.00	\$150,279.00	\$2,645.37	\$27,242.05	
		484,001.00	150,279.00	2,645.37	27,242.05	
<i>Receipts from sources other than Federal 1964-1965</i>						
State Appropriations for Agricultural Investigations						\$1,391,459.15
Special Endowments, Fellowships and Grants						42,375.37
Sales & Miscellaneous						174,591.54
						\$1,608,426.06
Total						\$58,012.51
						\$1,666,438.57
<i>Expenditures:</i>						
Personal Services		\$400,992.62	\$ 77,690.10	\$ 963.27	\$12,974.23	
Travel & Transportation		1,085.70	2,693.91	99.15	637.42	
Equipment		43,451.03	48,815.18	1,370.79	
Lands & Structures		4,013.55	175.00	
Supplies & Materials		24,965.44	12,376.83	483.97	985.45	
All Other		9,492.66	8,527.98	1,098.94	1,213.64	
Total		\$484,001.00	\$150,279.00	\$2,645.33	\$17,181.53	
Balance on June 30, 1965		\$484,001.00	\$150,279.00	\$2,645.33	10,060.52	
TOTALS						\$27,242.05

* Including Offset Funds

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1964 - 1965

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- A138 Hatching of the Eggs of Three Species of Aedine Mosquitoes in Response to Temperature and Flooding. Jerry Mallack, L. W. Smith, Jr., R. A. Berry, Jr., and W. E. Bickley. 21 pp. December, 1964.
- A139 Research Unlocks Agricultural Resources of Maryland (76th Annual Report of the Maryland Agricultural Experiment Station) I. C. Haut. 115 pp. June, 1964.
- 474 Comparison of Three Year Rotations in Maryland Tobacco Production. O. E. Street, J. H. Hoyert and C. G. McKee. 14 pp. January, 1965.
- 475 Comparison of Morea Versus Soybean Oil Meal as a Supplement for Finishing Beef Heifer Calves. John Buric and J. E. Foster. 5 pp. May, 1965.

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Department of Agricultural Economics

- 527 The Structure of Algerian Socialist Agriculture. P. W. Foster and Herbert Steiner. Multilithed Circular. 171 pp. July, 1964.
- 545 Changing Structure and Performance of the Northeastern Grain Marketing Industry, 1957-62. W. G. Heid, Jr., J. E. Martin and R. F. McDonald. Multilithed Circular. 111 pp. June, 1965.
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CURRENT PROJECTS

(These are projects and not publications available to the public.)

Department of Agricultural Economics

Project

- A-18-av An Analysis of the Economic Aspects of Beef Cattle Production in Maryland. S. Ishee and Graduate Assistant.
- A-18-aw Estimating the Returns to Inputs of Capital and Labor on Maryland Cash Grain and Tobacco Farms. J. P. Marshall and J. M. Curtis.
- A-18-ax Organization of the World's Agricultural Resources. P. W. Foster and Graduate Assistant.
- A-18/ay Profitability of Alternative Feed Handling Systems on Maryland Dairy Farms. J. W. Wysong and Graduate Assistant.
- A-18-az The Transfer of Farm and Open Country Real Estate in Six Selected Counties in Maryland in 1962. R. A. Murray and Graduate Assistant.
- A-19-y Assessment and Taxation of Farmland in the Rural-Urban Fringe in Maryland. F. D. Stocker, P. W. House, and W. P. Walker.
- A-19-z An Analysis of Practical Procedure for Equitable Taxation of Agricultural Land and Forest Tracts in Maryland. W. P. Walker and W. D. Gardner.
- A-19-aa The Impact of Economic Investments by Agricultural Product Processing and Marketing Firms Upon the Areas in Which the Investments are Made. J. R. Moore and R. E. DePass.
- A-19-ab United States Private Foreign Investment in Food Processing Plants in Latin America. J. R. Moore and Graduate Assistant.
- A-26-bc Adjustments of Maryland Milk Processing-Distribution Systems and Practices to Changing Condition. G. M. Beal, J. E. Martin and Yedla K. Rao.
- A-26-bf Improving Auction Warehouse Facilities and Methods of Marketing Maryland Tobacco. G. M. Beal, C. W. Coale, Jr., and Graduate Assistant.
- A-26-hg Analysis of the Impact of Farmer Cooperatives on the Agricultural Economy in Maryland. R. J. Beiter.
- A-26-bh Trends Pointing to Future Consumption and Market Potential for Meats in the Northeast. F. McDonald, H. D. Smith and Graduate Assistant.
- A-26-bj Changes in the Structure of the Northeast Processed Vegetable Industry. J. L. Cain, J. M. Curtis, and Graduate Assistant.
- A-26-bk Impact of the Chesapeake Bay Bridge-Tunnel on the Marketing of Soybeans, Corn and Feed Derivatives of these Grains, Through the Port of Baltimore. P. W. Foster and Graduate Assistant.
- A-26-bl Changing Structure and Performance of the Northeastern Markets for Grain. W. G. Heid, Jr.
- A-26-bm The Export Market for Maryland Agricultural Products. J. R. Moore and Graduate Assistant.
- A-26-bn The Application of Distributed Lag Models in the Estimation of Long-run and Short-run Elasticities. J. E. Martin.
- A-26-bo Analysis of Processing Efficiency and Costs in Broiler Processing Plants. J. C. Maness.
- A-26-bp An Analysis of the Current Structure of Livestock and Meat Marketing in Maryland and Surrounding Areas with Estimates Concerning the Future Structure. R. F. McDonald and H. D. Smith.
- A-26-bq Alternative Marketing Systems for Eggs in the Northeast. R. W. Schermerhorn, H. D. Smith, and Graduate Assistant.
- A-26-br Milk Assembly, Processing and Distribution Systems and Practices. G. M. Beal, J. M. Curtis, and Graduate Assistant.

- A-26-bs An Economic Analysis of the Role of Farmer Cooperatives as Marketing Organizations. R. J. Beiter.
- QA-58-s Effects of Alternative Vining Methods on Processing Cost and Quality of Lima Beans. D. A. Swope, B. A. Twigg, R. S. Fox, and L. C. O'Day.

Department of Agricultural and Extension Education

- T-6 Identification of High School Educational Experiences Affecting the Success of Students in the College of Agriculture. C. R. Smith.
- T-9 Relationship of Undergraduate Academic Achievement in College to Success in Teaching Vocational Agriculture. V. R. Cardozier.
- T-10 Testing a Procedure for the Improvement of the Reading Ability of Pupils in Vocational Agriculture Classes. V. R. Cardozier.
- T-12 An Analysis of the Factors Affecting the Status of Private Forest Recreation Development in Garrett County, Maryland. I. R. Jahns.

Department of Agricultural Engineering

- R-16 Pneumatic Handling of Chopped Forage. W. L. Harris, G. J. Burkhardt, K. E. Felton, R. L. Green, E. W. Martin, N. E. Collins and J. E. Foster.
- R-18 Development of Equipment and Improved Methods for Harvesting Sweet Potatoes. G. J. Burkhardt, E. W. Martin, R. L. Green and L. E. Scott.
- R-20 Principles of Mechanization in Harvesting Fruits and Vegetables. Principles of Separating Crop from Soil in Harvesting Root Crops. G. J. Burkhardt, P. N. Winn, Jr., R. L. Green and L. E. Scott.
- R-21 Development and Construction of Specialized Facilities and Equipment for Use in Agricultural Research. G. J. Burkhardt, W. C. Schaefer, E. W. Martin and R. L. Green.
- RB-11-g Tobacco Housing. P. N. Winn, R. L. Green, G. J. Burkhardt, E. W. Martin, N. Martin, John Hoyert, and O. E. Street.
- RM-1 Environmental Requirements of Poultry. P. N. Winn, N. Martin, C. S. Shaffner, and E. F. Godfrey.
- H-46-e Concentrated Pesticide Sprays. Evaluation of New Insecticides on Vegetable Crops. L. P. Ditman, G. J. Burkhardt and Graduate Students.
- RHB-23 Application of Energy for Control of Insects. W. L. Harris, N. A. Clark, A. L. Steinhauer and C. C. Blickenstaff.

Department of Agronomy

- B-43 Soybean Varietal Improvement. E. H. Beyer, J. L. Newcomer, B. E. Caldwell and C. E. Bass.
- B-50 Breeding for Better Dent Corn. R. G. Rothgeb and N. A. Clark.
- B-56-i Breeding of Improved Varieties of Forage Species Adapted to the Northeast. E. H. Beyer.
- B-56-j Pasture Evaluation Using Beef Steers. A. M. Decker, R. Z. Spry and J. E. Foster.
- B-66 Wheat Breeding and Evaluation. R. G. Rothgeb, J. L. Newcomer, and J. H. Axley.
- 3-67 Varietal Improvement in Barley and Oats. R. G. Rothgeb.
- 3-68 Effect of Rotational Practices Involving Various Legumes on the Growth, Quality and Composition of Maryland Tobacco. O. E. Street, W. B. Posey, G. L. Steffens, J. H. Hoyert, C. G. McKee, J. H. Mills and A. H. Hawkins.
- 3-73 Morphological and Physiological Responses of Perennial Forage Grasses. A. M. Decker, R. Z. Spry and N. A. Clark.
- 3-74 The Effects of Nitrogen Rates and Clipping Frequency on the Performance of Midland Bermudagrass (*Cynodon dactylon* (L.) Pers.). A. M. Decker.
- 3-75 Use of Sod-seeded Forage Crops to Supplement Existing Permanent Pastures. A. M. Decker, F. G. Swain, M. L. Sarna, A. L. Steinhauer, W. C. Hulbert and H. J. Retzer.

- B-76 Red Clover Breeding Investigations. E. H. Beyer.
- B-77 Forage Crop Variety Evaluation in Maryland. E. H. Beyer, A. M. Decker and N. A. Clark.
- B-78 The Control of Weeds in Cultivated Crops, Turf and Brush. J. A. Meade.
- B-79 Use of Herbicides to Control Weeds in Forages. J. A. Meade.
- B-82 Fertility and Clipping Management Effects on the Productivity and Persistence of Annual Pasture Grasses. N. A. Clark, H. R. Koller and D. T. Smith.
- B-85 Late Planting and Winter Survival in Oats. R. G. Rothgeb and Assistants.
- B-86 A Comparison of Silage Corn Grown Under High and Low Rates of Nitrogen When Fed to Milking Cows. N. A. Clark, R. W. Hemken, and J. H. Vandersall.
- B-87 Factors Contributing to Maximum Production in Maryland Tobacco. O. E. Street and J. H. Hoyert.
- B-89 Studies of Some Fundamental Physiochemical Relationships of Tobacco with Respect to Cultural, Fertilization, Curing and Fermentation Practices. O. E. Street, P. N. Winn and T. C. Tsou.
- B-94 The Effects of Physical Characteristics of Herbicides on Efficiency and Mode of Action When Used on Corn and Soybeans. J. A. Meade and S. R. Colby.
- B-95 Germination, Development and Competitiveness of Crabgrass (*Digitaria spp.*) Under Varying Environment Conditions. J. A. Meade.
- B-96 To Study the Effect of Controlled Environment on the Degree of Uniformity of Tobacco Seedlings. J. H. Hoyert and C. G. McKee.
- B-97 Differential Harvesting Management of Red Clover and Red Clover-timothy Stands Under Three Levels of Fertilization. A. M. Decker and L. R. Wade.
- B-98 Physiological and Biochemical Mechanism of Selectivity of Herbicides. S. R. Colby.
- B-99 Factors Related to Irrigation of Tobacco. O. E. Street, J. H. Hoyert, C. G. McKee and B. W. Byrd.
- B-101 The Effect of Modified Cultural Practices and Environmental Control of Curing Upon the Adaptability to Mechanization and Quality of Maryland Tobacco. J. H. Hoyert and P. N. Winn.
- B-103 Tobacco Breeding, Testing and Quality Evaluations of Maryland Tobacco. B. W. Byrd, Jr., O. D. Morgan, H. A. Skoog, C. G. McKee and A. C. Hawkins.
- BG-3 Cropping Systems for Dairy Farms: A Study of the Growth Responses of Corn and Alfalfa to Soil Fertility and Irrigation: with Concurrent Lactation Studies on the Effects of Corn Silage and Alfalfa Hay and Energy Levels on: Milk Production and Composition and the Physiology of Cows. (Coop. Department of Dairy Science) N. A. Clark, C. B. Kresge, J. H. Vandersall, and R. A. Hemken.
- O-48 Field and Laboratory Soil Characterization Investigations as Related to Soil Genesis, Classification and Utilization. J. A. Pomerening.
- O-54 Clay and Secondary Mineral Genesis in Maryland Soils. D. S. Fannin.
- O-55 Soil Test Studies. J. H. Axley, W. Winant, and E. Woolson.
- O-57 More Effective Use of Soil and Fertilizer Nitrogen. J. Axley.
- O-62 The Response of Forages and Certain Grain Crops to Fertilizers as Related to Rates and Ratios and Methods of Application. J. H. Axley.
- O-63 Response of Orchard Grass to Various Sources of Nitrogen and their Time of Application. C. B. Kresge.
- O-64 Effect of Nitrogen, Phosphorus and Potassium on the Growth and Development of Forages. C. B. Kresge, D. F. Champion, and V. A. Bandel.
- O-65 Legume Grass Mixtures in Relation to Differential Nitrogen Fertilization. C. B. Kresge.
- O-70 Relationship of Soil and Weather to Consumptive Use of Soil Moisture by Selected Field Crops. E. Strickling, D. Bandel and C. Stottlemeyer.
- O-71 Nutrient Balance in Orchardgrass as Related to Differential Fertilization. C. B. Kresge and V. A. Bandel.
- O-72 The Effects of Soil Aeration, Mechanical Impedance and Temperature on Root Growth. E. Strickling, D. Bandel and C. Britt.

Department of Animal Science

- C-21 The Effect of Specific Metabolites Upon Growth Rate and General Condition of Sheep. E. C. Leffel and J. H. Soares.
- C-25-a The Effects of Roughage Preparation. E. C. Leffel, B. B. Mahapatro and R. W. Farmer.
- C-33 A Study of the Effect of Menhaden Fish Meal on the Quality of Protein of Swine Diets and on Total Crude Protein Requirements for Growth of Swine. E. P. Young, J. E. Foster, D. H. Snyder and R. R. Kifer.
- C-34 A Study of the Nutritional and Physiological Influences on Variability of Ovulation Rate and Embryonic Survival in Swine. E. P. Young, J. E. Foster and H. J. Brinkley.
- C-35 Studies on the Efficiency and Composition of Growth in Swine as Affected by Protein and Energy Consumption. E. P. Young and E. C. Leffel.
- C-36 A Study of Factors Affecting the Utilization of Non-protein Nitrogen in High Roughage Diets for Ruminants. E. C. Leffel, N. Satapathy, B. B. Mahapatro and J. E. Foster.
- C-38 A Study of Factors that Influence Feed Consumption by Suckling Pigs. E. P. Young and J. E. Foster.
- C-39 Analyses of Records of Beef Cattle Herds in Maryland. W. W. Green, J. E. Foster, J. B. Lingle and J. L. Carmon.
- C-40 A Study of the Use of Measurements for the Evaluation of Beef Breeding Cattle. W. W. Green, W. R. Stevens, J. E. Foster and J. L. Carmon.
- C-41 A Study of Variations in Values of Criteria Used in Selection Indices for Beef Cattle. J. Buric, J. E. Foster and W. W. Green.
- C-42 A Study of Rates of Ruminal Digestion and Absorption from the Rumen. E. C. Leffel, R. W. Farmer, M. H. Abbassy, D. F. Wilson, and J. E. Foster.

Department of Botany

- F-12 The Native Plants of Maryland, Their Occurrence, Distribution and Economic Importance. R. G. Brown, C. C. Phillip, Jane A. Engh and W. O. Mercer.
- F-18 Genetic Control of the First Division Association of Homologous Chromosomes and Fertility in *Zea mays* and *Capsicum frutescens*. D. T. Morgan, Jr., and R. L. Baker.
- F-19 Anatomical Physiological and Ecological Studies on *Myriophyllum spicatum*. L.R. G. Brown, R. D. Rappleye, R. Anderson and H. Weirick.
- F-20 An Ecological Study of the Patuxent Estuary. R. G. Brown, R. D. Rappleye, R. Anderson, R. Sommer and C. Phillip.
- J-91 Fungicidal Materials on Cellular Metabolism and Their Usefulness for the Field Control of Vegetable Diseases. H. D. Sisler, J. G. Kantzes, M. R. Siegel, R. A. Paterson and Graduate Assistant.
- J-93 Treatment of Soil and Underground Parts of Plants for the Control of Plant Diseases. O. D. Morgan, J. G. Kantzes, L. R. Krusberg, F. J. Williams, W. L. Klarmann and E. H. Beyer.
- J-95 Development of Improved Strains of Maryland Tobacco Resistant to Diseases. O. D. Morgan, B. W. Byrd, O. E. Street, J. Hoyert, H. E. Heggested and H. A. Skoog.
- J-97 Physiology of Plant Parasitic Nematodes and the Plant Nematode Interaction. L. R. Krusberg, R. K. Howell, R. J. Cole, H. G. Cutler and R. W. Powitz.
- J-98 Identification, Characterization and Control of Certain Viruses Affecting Economic Plants in Maryland. H. D. Sisler, O. D. Morgan and Graduate Assistant.
- J-99 The Nature and Control of Diseases of Ornamentals and Turf Grasses in Maryland. W. L. Klarmann, A. A. Bell and Graduate Assistant.
- J-100 Nature and Control of Major Field and Storage Diseases of Sweet Potatoes in Maryland. J. G. Kantzes.

- J-101 Forest Tree Seedlings and Soil Fungi Relationships. W. L. Klarman, W. K. Hock and Graduate Assistant.
- K-8-c Biophysical and Biochemical Factors in Plant Nutrition. H. Gauch, R. Krauss, R. Galloway, J. Bowen, and M. Abdel Halim.

Department of Dairy Science

- G-34 Chemical Changes in Milk Fat as Related to the Flavor of the Milk. R. L. King.
- G-35 The Analysis of Dairy Products. R. L. King.
- G-37 Physiology of Metabolic Diseases of Cattle. W. E. Stewart, H. F. Downey, W. G. Esmond, C. Short, R. O. Scow, R. Kretchmar, S. Perry, J. C. Smith, T. B. Bowian, R. J. McCormick, R. G. Cragle, J. H. Nicolai and G. Henning.
- G-39 Studies on the Mode of Digestion, Absorption and Utilization of Feeds by Ruminants and their Associated Bacteria. W. E. Stewart, R. L. King, R. W. Hemken, B. B. Bush, J. H. Nicolai, F. C. Blank, C. E. Coppock, W. G. Esmond and I. L. Lindahl.
- G-42 Methods of Processing and Other Factors Affecting the Quality of Ice Cream. W. S. Arbuckle.
- G-46 The Relationship of the Hypophyseal Growth Hormone and of the Pituitary-Adrenal System to the Productive Capacity of Dairy Cattle for Reproduction and Milk Production. W. F. Williams.
- G-47 The Nutritive Evaluation of Forages. R. W. Hemken, R. F. Davis, N. A. Clark and A. M. Decker.
- G-48 Flavor Quality of Concentrated Milk Products as a Factor in Milk Utilization and Marketing. M. Keeney and I. Katz.
- G-50 The Physiology of Progesterone Metabolism. W. F. Williams, G. D. Turner and A. Wieshaar.
- G-52 A Study of Factors Affecting the Voluntary Intake, Availability and Utilization of Nutrients in Forages for Growth and Milk Production. R. W. Hemken, J. H. Vandersall and R. F. Davis.
- G-53 A Study of the Development, Improvement or Standardization of Manufacturing Processes for the Production of Various Cheeses and the Effect of Specific Factors on the Flavor, Body and Texture of these Cheeses. J. H. Mattick.
- G-54 Analyses of Production and Feed Data from Dairy Records. J. L. Cason.
- GC-45 Studies of the Physiological and Biochemical Nature of Bloat. (Coop. Department of Animal Science) W. E. Stewart, J. C. Smith, E. C. Leffel, B. B. Mahapatro, R. W. Farmer and E. E. Bartley.
- BG-2 Grazing Study with Lactating Dairy Cows on Summer Annual Pastures. (Coop. Department of Agronomy) R. W. Heinken, J. H. Vandersall, P. R. Peta and N. A. Clark.

Department of Entomology

- H-29-n Chemical Control of Insect Pests of Sweet Corn. F. P. Harrison and L. P. Ditman.
- H-46-e Concentrated Pesticide Sprays. Evaluation of New Insecticides on Vegetable Crops. L. P. Ditman and G. J. Burkhardt.
- H-48 Chemical Control of Orchard Insects. W. E. Bickley, C. Graham and E. R. Krestensen.
- H-64 An Evaluation of the Effectiveness of Commercial Insect Control Practices on Canning Crops. L. P. Ditman.
- H-67 Pesticide Residues in or on Raw Agricultural Commodities. Katherine A. Nelson, R. E. Menzer and L. P. Ditman.
- H-71-d Alfalfa Insects, Their Biology and Control. A. L. Steinhauer and H. D. Byrne.
- H-72 Physiology of Insect Reproduction. J. C. Jones, D. P. Liu, M. Sullivan and K. W. Ludlam.

- H-73-a The Mosquito Fauna in Selected Swamps, Marshes and Impoundments. W. E. Bickley.
- H-74 Biology and Control of Tobacco Insects. F. P. Harrison.
- H-76 Comparative Morphology and Physiology of Insect Blood Cells. J. C. Jones, D. P. Liu and R. Werner.
- H-78 Metabolism of Essential Nutrients and Insecticidal Chemicals in Insects. A. L. Steinbauer.
- H-80 Classification of the Neotropical Mosquitoes of the Subgenus *Culex*. R. A. Bram, W. E. Bickley and A. Stone.
- H-81 Utilization of the Polyhedrosis Virus for Commercial Control of the Cabbage Looper. L. P. Ditman, L. Kulp and R. Hofmaster.
- H-82 Chemosterilization of Insects. W. E. Bickley and W. S. Murray.
- H-83 Biology and Control of Loblolly Pine Cone Insects in Maryland. W. E. Bickley, F. E. Wood, and R. C. Moore.
- H-84 Host Preference of Alfalfa Weevil in Relation to Plant-produced Attractants and Repellents. A. L. Steinbauer.
- H-85 Metabolic Transformations of Dimethoate by Plants. R. E. Menzer.
- H-86 The Biology of Biting Midges of the Genus *Culicoides* in Maryland. D. E. Messersmith.
- H-87 The Control of Bird Depredation. D. E. Messersmith.

College of Home Economics

- Y-1 The Effect of Different Quality and/or Quantities of Dietary Protein on serum Lipid Levels. Pela Braucher, Virginia Dawson, Genevieve Watkins, E. C. Cox and L. M. Dyke.
- Y-2 Properties of Textile-Furnishing Fabrics and Their Importance to Consumer Satisfaction. Eleanor Young and T. Faye Mitchell.
- Y-3 Fertilization Effects on the pH, Titratable Acidity, Chlorophyll and Carotene Content of Broccoli. Mary S. Eheart, Dale Queen and Betty Lugenbill.
- Y-4 Utilization of Amino Acids from Proteins. Pela Braucher, Virginia Dawson, Genevieve Watkins, E. C. Cox and L. M. Dyke.

Department of Horticulture

- I-74-a Effect of Environmental Factors and Cultural Practices on the Growth and Flowering of Greenhouse Potted Plants. J. B. Shanks, C. B. Link, W. Noble and F. J. Marousky.
- I-74-b Effect of Environmental Factors and Cultural Practices on the Growth and Flowering of Greenhouse Cut Flower Crops. C. B. Link, J. B. Shanks, J. Swasey and F. Couin.
- I-79-1 Physiological Differences of Winter and Summer Flowering Varieties of Snapdragons as Related to Growth and Flower Quality. C. B. Link, K. C. Sanderson and J. B. Shanks.
- I-79-m Relationship of the Mineral Nutrients and of Nutrient levels to the Growth and Development of Certain Woody Ornamental Plants Growing in Containers. C. B. Link and F. Couin.
- L-73 Adaptation of Fruit Varieties and New Seedlings to Maryland. I. C. Haut, F. J. Lawrence and W. A. Matthews.
- L-74 Environmental Factors and Cultural Practices in Relation to the Growth and Fruiting Responses of Fruits. A. H. Thompson and B. L. Rogers.
- L-74-b Chemical Thinning of Apples and Peaches. A. H. Thompson and B. L. Rogers.
- L-74-c Size Control of Fruit Trees with Chemicals. A. H. Thompson and B. L. Rogers.
- L-79-e Mineral Nutrition of the Apple with Reference to the Development of Cork Spot and to Respiration, Enzyme Activity and Storage Life. A. H. Thompson, B. L. Rogers and H. G. Gauch.

- L-79-f Post Harvest Physiology of Pomological Fruits. L. E. Scott, J. C. Raulston, M. D. Moore and S. H. Todd.
- L-100 Vegetative Propagation of Pine by Needle Fascicles. I. C. Haut, R. L. Baker and W. C. Armbrust.
- Q-58-a Rapid Nutritive Evaluation of Processed Vegetables. A. Kramer, L. E. Scott, E. A. Ahmed, Helen J. M. Thompson, I. M. Ben-Sinai and S. J. Palmer.
- Q-58-m Development of New Products and Improved Processing Methods. R. C. Wiley, A. Kramer, B. A. Twigg, L. E. Scott, Mildred Modery, J. L. Collins and T. Chase.
- Q-58-n Suitability of New Varieties of Horticultural Crops for Canning and Freezing. W. L. Hollis.
- Q-58-p Quality Improvement of Canned Apple Slices and Sauce Through Studies of the Relation of Water Insoluble Constituents of the Fresh Fruit to the Textural Quality of the Processed Product. R. C. Wiley, A. H. Thompson, Mildred Modery, J. L. Collins, D. White, T. Chase, R. Dougherty and M. Tavakoli.
- Q-58-r Quality Maintenance, Measurement and Control in the Marketing of Vegetables, Including Potatoes. A. Kramer, R. C. Wiley, B. A. Twigg, W. L. Hollis, Mildred Modery, S. Angel and J. Yeatman.
- Q-58-s Quality Maintenance, Measurement and Control in the Marketing of Vegetables, Including Potatoes. A. Kramer, B. A. Twigg, I. Ben-Sinai, S. J. Palmer and H. Todd.
- Q-74 A Study of Regional Adaptation of Certain Vegetable Crops and Varieties in Maryland. W. L. Hollis and F. C. Stark.
- Q-77 Crop Management Studies with Vegetable Crops. W. L. Hollis, F. C. Stark and C. W. Reynolds.
- Q-77-b Efficacy and Selectivity of Chemical Herbicides for Controlling Major Weed Species in Truck Crop Production. J. D. Long, W. A. Matthews, G. J. Stadelbacher and F. C. Stark.
- Q-81 Cantaloupe Breeding and Selection with Particular Reference to Quality and Resistance to Defoliation. F. C. Stark and W. A. Matthews.
- Q-81-b Sweet Potato Breeding and Selection with Particular Reference to Quality and Resistance to Cracking. F. C. Stark, W. A. Matthews, D. A. White and J. D. Long.
- Q-81-c Sweet Corn Breeding with Particular Reference to the Utilization of Cytoplasmic Male Sterility in the Production of F₁ Hybrid Seed Corn. R. J. Snyder and P. Nugent.
- Q-81-d Tomato Breeding and Selection with Particular Reference to Adaptation to Mechanical Harvest and to Processing. F. C. Stark, W. A. Matthews, D. A. White, and J. D. Long.
- Q-83 Soil and Plant Factors Affecting Water Utilization by Selected Vegetable Crops. C. W. Reynolds and F. C. Stark.
- Q-83-b Root Distribution and Root Density of selected Vegetable Crops as Related to the Absorption of Soil Water and the Uptake of p³². C. W. Reynolds and R. J. Adkins.

Department of Poultry Science

- M-32-m Genetic Differences in Alkaline Phosphatase Concentration of Blood Sera as Related to Differences in Egg Production and Egg Quality. F. H. Wilcox, C. S. Shaffner and W. S. Cloud.
- M-55 The Perception and Preference of Chickens for Different Colors. G. D. Quigley.
- M-58 Metabolic and Nutritional Studies on Microorganisms Important to the Poultry Industry. Mary S. Shorb, Pauline G. Lund, W. O. Pollard and D. A. Shorb.
- M-59 Lipid Metabolism of Fowl Spermatozoa. Mary S. Shorb, B. Dunlap and B. Lutsky.
- M-61 A Study of Causes of Bruising in Transportation of Live Broilers from Farm to Processing Plant and Possible Methods for their Reduction. N. V. Helbacka and D. H. Sanders.

- M-62 The Effect of Folic Acid Supplementation of a Practical Type Turkey Breeder Ration on Hatchability of Eggs and Quality of Offspring. C. S. Shaffner and W. C. Supplee.
- M-63 A Study of the Relationship of Vitamin E to the Enlarged Hock Disorder in Turkey Pouls. W. C. Supplee.
- M-64 Effects of Gonadal Hormones on Embryonic and Postnatal Bone Growth in Chickens. E. F. Godfrey and C. S. Shaffner.
- M-65 Further Investigations Regarding Systemic Insecticides of Poultry. G. D. Quigley.
- M-66 Applied Broiler Nutrition Studies. G. F. Combs, J. L. Nicholson, E. F. Godfrey and E. Bossard.
- M-100 Quality Retention in Poultry Meats as Influenced by Methods of Processing. N. V. Helbacka, C. J. Smith, A. Kotula and C. S. Shaffner.
- M-206 A Study of the Calcium Requirement of Young Turkeys. W. C. Supplee.
- M-207 Study of Chick RBC Transketolase as an Index of Thiamine Nutriture. G. F. Combs and P. Padhi.
- M-208 Use of Chick Bio-Assay in Measuring Specific Amino Acid Availability. G. F. Combs, E. Bossard, V. Vasaitis and D. Blamberg.
- M-209 Effect of Protein Level and Amino Acid Balance on Voluntary Food Consumption. G. F. Combs, D. L. Blamberg, V. Vasaitis, and A. Khalil.
- M-210 Determination of Amino Acid Requirements of Growing Broiler Chicks and Laying Hens. G. F. Combs, D. L. Blamberg, E. Bossard, V. Vasaitis, F. R. Shank, O. P. Thomas, P. F. Twining and W. L. Payne.
- M-302 Effect of Freezing and Reversible Inhibitors on Chicken Sperm. F. H. Wilcox and C. S. Shaffner.
- M-303 The Performance of Populations of the Domestic Fowl as Influenced by Heritable Physiological Traits and by Genes with Pleitropic Effects. F. H. Wilcox, C. S. Shaffner and W. S. Cloud.
- M-400 Effect of Protein Adequacy on the Efficiency of Selection for Early Fattening of Turkeys. C. S. Shaffner, G. F. Combs, G. D. Quigley and E. Godfrey.

Department of Veterinary Science

- D-52 Respiratory Disease of Poultry. F. K. Wills and I. M. Mouthrop.
- D-57 Epizootiology of Equine Encephalitis in Maryland. H. M. DeVolt, M. J. Collins Jr., Frances S. Yancey, R. W. March and J. Sharp.
- D-58 An Investigation to Study the Use of the Tetrazolium Salts in a Rapid Screen Test and Rapid Sensitivity Test in Mastitic Milk. Elizabeth J. Schultz and Barbara Reisner.
- D-59 The Investigation of Fluorescent Antibody Technique with Respiratory and Other Diseases. H. M. DeVolt, R. L. Peters and Willene Keenum.
- D-60 Investigations on Brucellosis of Cattle. Cornelia M. Cotton.
- D-62 Infectious Diseases Affecting Reproduction in Cattle with Special Reference to Vibriosis and Leptospirosis. G. J. Plumer, Virginia Shepler, Frances S. Yancey and W. R. Anderson.
- D-63 Study of Bovine Respiratory Diseases. S. B. Mohanty, M. G. Lillie, and G. J. Spahn.
- D-64 An Investigation to Study the Propagation of Avian Viruses in Tissue Culture. H. M. DeVolt, V. W. Mayer and Willene Keenum.
- D-65 Studies on Etiology and Pathogenesis, Laboratory Diagnosis and Chemotherapy of Bovine Lymphosarcoma. B. C. Hatzios.
- D-66 A Study of the Toxic Substance Produced by *Stachybotrys O'tra*. R. B. Johnson and H. M. DeVolt.



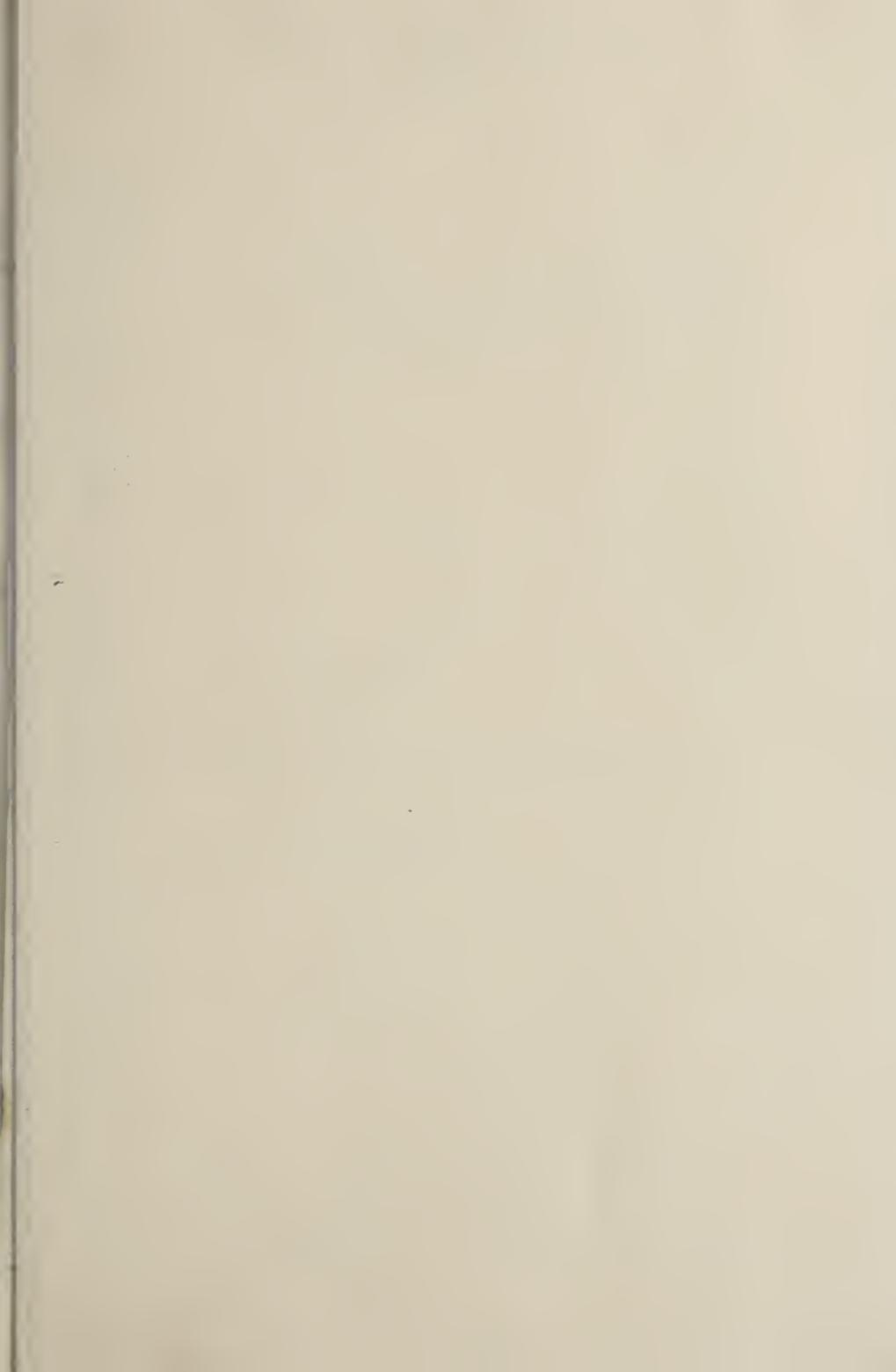
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